ISSN 0377-9335

entomon

A Quarterly Journal of Entomological Research

Vol. 5 MARCH 1980 No. 1

PUBLISHED BY

THE ASSOCIATION FOR ADVANCEMENT OF ENTOMOLOGY

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF KERALA, KARIAVATTOM,

TRIVANDRUM, INDIA 695581

ENTOMON

Entomon is a quarterly journal of the Association for Advancement of Entomology issued in March, June, September and December, devoted to publication of research work on various aspects of insects and other land arthropods excluding gross anatomy, histology and morphology.

Address MS and all editorial correspondence to the Managing Editor, *Entomon*, Department of Zoology, University of Kerala, Kariavattom, Trivandrum, India 695581.

SUBSCRIPTION RATES

Annual subscription for institutions: Rs 80/- (in India); $ 30/- (abroad)
" " individuals: Rs 50/- " ; $ 20/- "

ADVERTISEMENT RATES

Full page Rs 200/-; Half page Rs 125/-; quarter page Rs 75/-

Address all business correspondence to the Secretary-Treasurer of the Association.

---

1. **All remittances to the journal or the Association should be sent to the Secretary-Treasurer of the Association.**
2. **Cheques should be A/c payee in favour of the Association for Advancement of Entomology.**
3. **Requests for replacement copies of ENTOMON in lieu of numbers lost in transit, should reach the Secretary – Treasurer not later than three months (nine months for requests from abroad) after the date of issue of the number.**

entomon

Volume 5 March 1980 Number 1

CONTENTS

BRIEF COMMUNICATIONS

REPORTS AND NEW RECORDS

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 1 *to* 12

INTERSPECIFIC CHROMOSOMAL VARIATION AMONG A FEW MEMBERS OF THE *NASUTA* SUBGROUP (GENUS : *DROSOPHILA*)

M. R. RAJASEKARASETTY, S. R. RAMESH & N. B. KRISHNAMURTHY
Department of Post-Graduate Studies & Research in Zoology,
Manasagangotri, University of Mysore, Mysore, India 570 006

(*Received 18 August 1979*)

Seven fixed inversions and two transpositions are detected in the polytene chromosomes of the hybrid larvae and in optical comparisons of parental larvae of those which could not be hybridized. Three of these fixed inversions are also known as extant polymorphs. The results of the present investigations permit to infer that X chromosome is more stable and chromosomes 2 and 3 are favourable in fixing the gene complexes in the members of the *nasuta* sub group. Further, evidences exist for both presence and absence of correlation between morphological and chromosomal differentiation.

(*Key words:* **interspecific chromosomal variation, *Drosophila*, *nasuta*, inversion, transposition, polytene chromosomes**)

INTRODUCTION

Interspecific polytene chromosome comparison yields information on the extent to which the chromosomal rearrangements have been involved in the past evolutionary divergence in a species group or a complex.

Drosophila nasuta subgroup of the *immigrans* species group of the genus *Drosophila* is an assemblage of almost morphologically identical species. Females of this subgroup are morphologically similar and cannot be told apart, while the males have silvery markings on the frons. The extent of such markings varies. Based on this character, NIRMALA & KRISHNAMURTHY (1972) have divided this subgroup into three morphophenotypic complexes, namely: (1) Frontal sheen complex, which includes species with silvery sheen over the entire frons—*D. nasuta nasuta*, *D. n. albomicana*, *D. n. kepulauana* and *D. kohkoa*; (2) Orbital sheen complex, which includes species with silvery markings confined to the sides of the frontal orbits–*D. nixifrons*, *D. sulfurigaster sulfurigaster*, *D. s. albostrigata*, *D. s. bilimbata*, *D. s. neonasuta* and *D. pulaua*; (3) Species without any such silvery markings on the frons—*D. pallidifrons*.

Though studies on cytogenetic interrelationships (WILSON *et al.*, 1969; NIRMALA & KRISHNAMURTHY, 1973–74; RANGANATH *et al.*, 1974; RANGANATH & KRISHNAMURTHY, 1976), courtship and mating behaviour (SPEITH, 1969) have been made, still information on the role of structural rearrangements in the differentiation of members of *D. nasuta* subgroup is wanting. WILSON *et al.*, (1969) were able to detect some fixed inversions in their studies, but they did not take them into consideration to understand the interrelationships among the members of the subgroup. Recognising this lacuna, the authors have undertaken the present investigations to evaluate the role of chromosomal rearrangements in the phylogenetic divergence of the members of *nasuta* subgroup.

MATERIALS AND METHODS

The parental stocks were checked for the presence of chromosomal rearrangements and if there

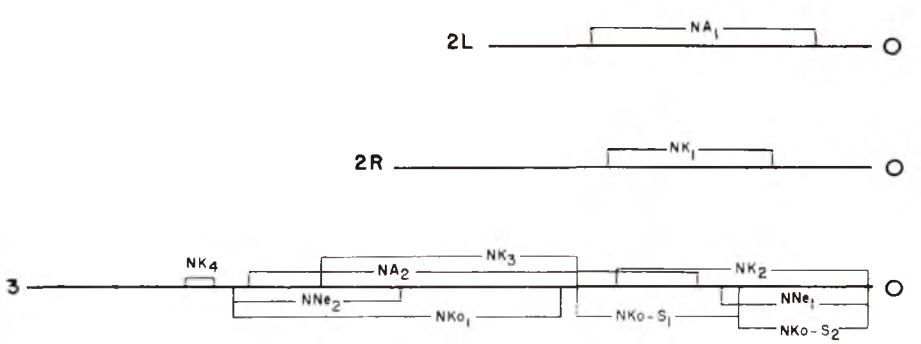


Fig. 1. Distribution of breakpoints of rearrangements encountered in the interspecific crosses/ chromosome comparisons, relative to the standard sequence. The open circles at the right ends represent the basal ends of the chromosomes.

were any, their frequencies were recorded. Table 1 depicts the stocks, their geographic origin and the genotype, used for the present hybridization experiments to evaluate the chromosomal differentiation between different members of the *nasuta* subgroup.

Mass matings were made in all the crosses using five days old virgin flies, in small vials of 3" × 1" size containing wheat cream agar medium. The flies were transferred to fresh food vials once in a week and was followed upto 4 weeks. In the meanwhile if no larvae emerge out of these transferred vials, the crosses were considered to be unsuccessful. Such crosses were repeated thrice to confirm the results. If the crosses were fertile, the salivary gland chromosomes of the hybrid larvae were analysed for the fixed chromosomal rearrangements. In cases where the homologies of the chromosomes could not be analysed in the salivary glands of the hybrid larvae due to incompatibility of the parents, a direct optical comparison of the parental larvae was made. For salivary gland chromosome preparation, procedure of RANGANATH & KRISHNAMURTHY (1975) was followed. In each cross or optical comparison at least 50 slides were scored for the rearrangements. Each interspecific chromosmal difference was localized on the standard photomap of *D. n. nasuta* made by RANGANATH & KRISHNAMURTHY (1973–74) and their distribution in different arms is given in Fig. 1.

In order to facilitate easy recognition of the rearrangements detected in the interspecific crosses and comparisons from the intraspecific inversions, the following method of nomenclature is herein followed. The procedure in the terminology is as follows; the inversions or rearrangements are given numbers (in the order of discovery) added to symbols that indicate species crosses/comparisons in which they occur. The symbols used are, N for *D. n. nasuta*, A for *D. n. albomicana*, K for *D.n. kepulauana*, Ko for *D. kohkoa*, P for *D. pulaua*, S for D. *s. sulfurigaster*, Ne for *D. s. neonasuta*, Al for *D.s. albostrigata* and B for *D. s. bilimbata*.

RESULTS

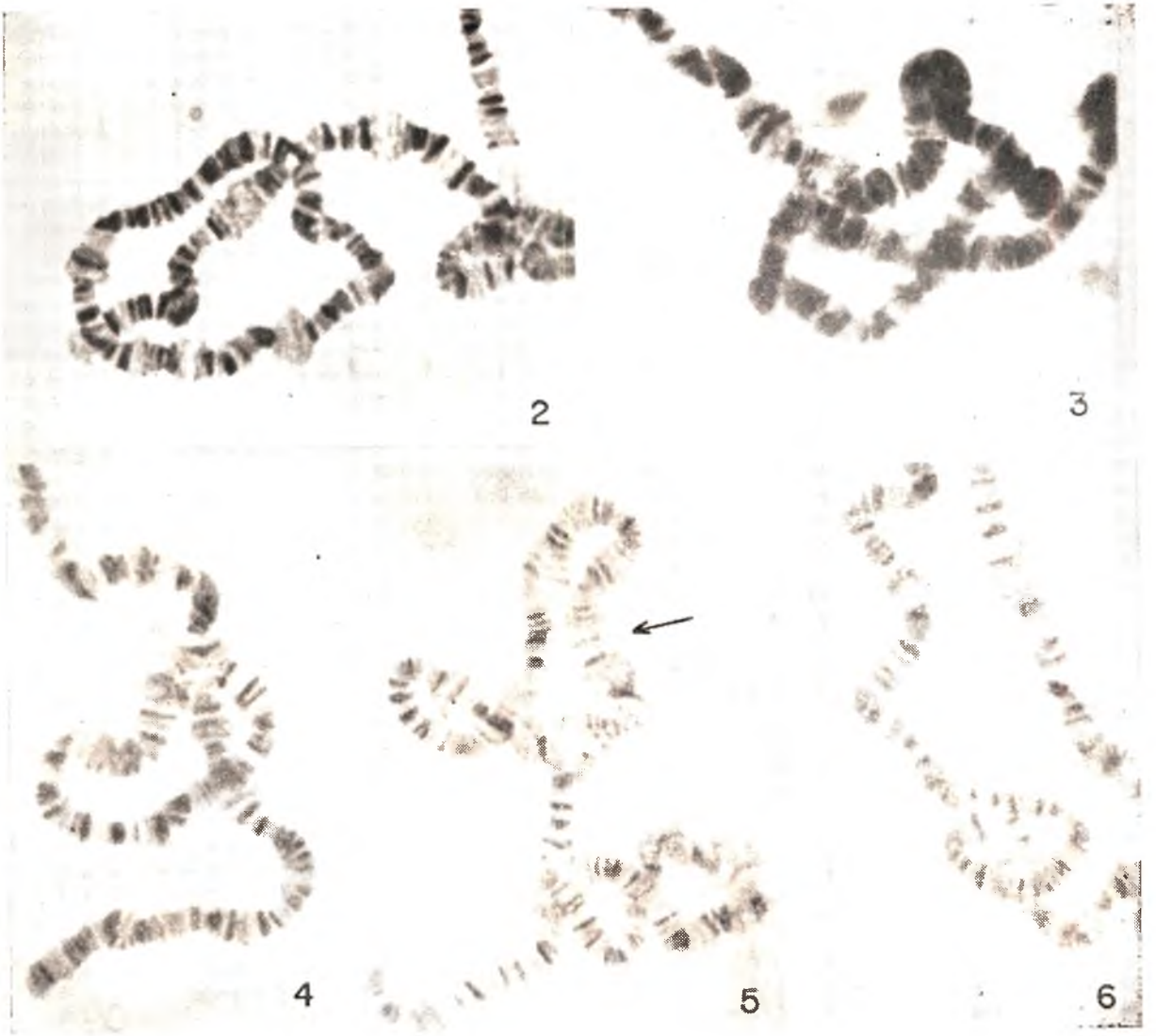
The salivary gland chromosome complement in the members of *nasuta* subgroup includes four long arms namely X chromosome 2 (2L), right arm of chromosome 2 (2R) and chromosome 3 and a short arm, chromosome 4.

Perusal of Table 1 reveals that all the parents used for the present studies are free of rearrangements except two viz., *D. n. kepulauana* and *D. s. albostrigata*. The results of the crosses carried out between different members are compiled in Table 2. Table 3 gives the type of chromosomal rearrangements, their location and frequency pertaining to particular crosses as well as cytological comparisons.

The chromosomes of the F_1 hybrids are as follows:

D. n. nasuta × *D. n. albomicana*

Left arm of the second chromosome (2L) and the acrocentric chromosome 3 are the



D.n. nasuta × *D.n. albomicana*: Fig. 2. Inversion NA_1 – Chromosome 2L; Fig. 3. Inversion NA_2–Chromosome 3. *D. n. nasuta*×*D.n. kepulauana*: Fig. 4. Inversion NK_1–Chromosome 2R; Fig. 5. Inversion NK_2 (indicated by arrow) and Inversion NK_3 – Chromosome 3; Fig. 6. Inversion NK_4 – Chromosome 3.

Fixed rearrangements encountered in the chromosome comparisons. Fig. 7. Chromosome 3 of *D.n. nasuta* (Standard). Fig. 8. Chromosome 3 of *D. kohkoa*. Fig. 9. Chromosome 3 of *D.s. neonasuta*. C – Centromeric end.

TABLE 1. Memebers of *D. nasuta* subgroup used in the present studies along with their geographic origin and genotype.

Species	Geographic origin	Genotype
D. nasuta nasuta	Coorg, (Karnataka, India)	Monomorphic.
D. nasuta albomicana	Okinawa	Monomorphic.
D. nasuta kepulauana	Sarawak	Heterozygous for inversion DD (22%) in chromosome 2R and another in chromosome 3.
D. Kohkoa	Gulf of Thailand	Monomorphic.
D. sulfurigaster neonasuta	Coorg, (Karnataka, India)	Monomorphic.
D. sulfurigaster sulfurigaster	Wau, (New Guinea)	Monomorphic.
D. sulfurigaster albostrigata	Mt. Makeling, (Laguna)	Heterozygous for inversion 2LA (36%) in chromosome 2L.
D. sulfurigaster bilimbata	Suva, Fiji	Monomorphic.
D. pulaua	Sarawak	Monomorphic.

only ones which showed inversions in the hybrid progeny. 2L: One fixed inversion named NA_1 (Fig. 2) similar to 2LB and 2LA found as extant polymorphs in the natural populations of *D. n. nasuta* and *D.s. neonasuta* respectively (NIRMALA & KRISHNAMURTHY, 1974; RANGANATH & KRISHNAMURTHY, 1975). 3: One fixed inversion named NA_2 (Fig. 3) is found.

D. n. nasuta × *D. n. kepulauana*

Only chromosome 2R and chromosome 3 showed heterozygous inversions in the hybrid larvae. 2R: One fixed inversion named NK_1, (Fig. 4) similar to D_3 which is polymorphic in natural populations of *D.s. albostrigata* (MATHER *et. al.*, 1974). 3: Three inversions named NK_2, NK_3, (Fig. 5) and NK_4 (Fig. 6). Of these three inversions, NK_2 is fixed while the other two are polymorphic. It is also observed that the hybrid larvae carried NK_2 either with NK_3 or NK_4 but never all the three together. Further NK_3 and NK_4 are never found together. None of the parental inversions are encountered in the hybrids.

D. s. neonasuta × *D. s. sulfurigaster*

2L: Inversion NA_1 described in the hybrids of *D. n. nasuta* × *D. n. albomicana* has been detected. The other chromosmes were free of inversions or rearrangements.

D. s. neonasuta × *D. s. bilimbata*

Only chromosome 2L carried fixed inversion in the hybrid progeny of this cross 2L: One fixed inversion similar to NA_1 which is found in the hybrids of *D. s. neonasuta* × *D. s. sulfurigaster* and *D. n. nasuta* × *D. n. albomicana* has been observed. It is clear that the arrangement found in chromosome 2L of *D.s. bilimbata* is same as that of *D. s. sulfurigaster*.

♂♂ / ♀♀	*D.n.nasuta*	*D.n.albomicana*	*D.n.kepulauana*	*D.kohkoa*	*D.s.neonasuta*	*D.s.sulfurigaster*	*D.s.albostrigata*	*D.s.bilimbata*	*D.pulaua*
D.n.nasuta		F	F	S	S	S	S	S	S
D.n.albomicana	F		S	S	S	S	S	S	S
D.n.kepulauana	F	S		S	S	S	S	S	S
D.kohkoa	S	S	S		S	S	S	S	S
D.s.neonasuta	S	S	S	S		F	F	F	F
D.s.sulfurigaster	S	S	S	S	F		F	F	F
D.s.albostrigata	S	S	S	S	F	F		F	F
D.s.bilimbata	S	S	S	S	F	F	F		F
D.pulaua	S	S	S	S	F	F	F	F	

F = Parents cross fertile

S = Parents cross sterile

Thick squares depict the occurrence of fixed inversions

Table 2. Results of the crosses between different members of *nasuta* subgroup.

D. s. neonasuta × *D. pulaua*

Except chromosome 2L, all other chromsomes are devoid of any rearrangements. 2L: One fixed inversion similar to NA. described in the hybrids of the crosses *D. n. nasuta* × *D. n. albomicana*, *D. s. neonasuta* × *D. s. sulfurigaster* and *D. s. neonasuta* × *D.s. bilimbata* has been detected. Thus the gene arrangement in chromsome 2L of *D. pulaua* is similar to *D. s. sulfurigaster* and *D. s. bilimbata*.

D. s. neonasuta × *D. s. albostrigata*

The only chromosome arm that showed inversion in the hybrid larvae of this cross is chromosome 2L where one polymorphic inversion similar to NA_1 (80%) described earlier, is observed.

D. s. sulfurigaster × *D. s. bilimbata*

All the hybrids of this cross were found to be free of chromosomal rearrangements revealing that they are homosequential forms.

D. s. sulfurigaster × *D. pulaua*

No rearrangements are detected in any chromosome, from which one can conclude they are homosequential.

TABLE 3. Chromosomal rearrangements, their location and frequency encountered in particular crosses and cytological comparisons.

Crosses	Rearrangement	Chromosome	Frequency
D. n. nasuta × *D.n. albomicana*	Inversion–NA_1	2L	100%
	Inversion–NA_2	3	100%
D.n. nasuta × *D.n. kepulauana*	Inversion–NK_1	2R	100%
	Inversion–NK_2	3	100%
	Inversion–NK_3*	3	63%
	Inversion–NK_4*	3	37%
D.s. neonasuta × *D.s. sulfurigaster*	Inversion–NA_1	2L	100%
D.s. neonasuta × *D.s. bilimbata*	Inversion–NA_1	2L	100%
D.s. neonasuta × *D.s. albostrigata*	Inversion–NA_1	2L	80%
D.s. neonasuta × *D. pulaua*	Inversion–NA_1	2L	100%
D.s. albostrigata × *D.s. bilimbata*	Inversion–NA_1*	2L	50%
D.s. albostrigata × *D.s. sulfurigaster*	Inversion–NA_1*	2L	50%
D.s. albostrigata × *D. pulaua*	Inversion–NA_1*	2L	50%
Cytological comparison			
D.n. nasuta and *D. kohkoa*	Shift–$NKo–S_1$	3	100%
	Shift–$NKo–S_2$	3	100%
	Inversion–NKo_1	3	100%
D.n.nasuta and *D.s. neonasuta*	Inversion–NNe_1	3	100%
	Inversion–NNe_2	3	100%

*Polymorphic inversions.

D. s. bilimbata × *D. pulaua*

Rearrangements are absent in the salivary gland chromosomes of the hybrids of this cross which indicates the homosequential nature of their chromosomes.

Cytological comparison of salivary gland chromosomes of D. n. nasuta *and* D. kohkoa

Except chromosome 3, all others are devoid of any fixed rearrangements. 3: One fixed inversion named NKo_1, two transpositions/shifts named $NKo–S_1$ and $NKo–S_2$ (Fig. 7), are detcted.

D. n. nasuta *and* D. s. neonasuta

Only chromosome 3 carried two fixed inversions, named NNe_1, and NNe_2 (Fig. 8). Of these two, NNe_2 is similar to inversion 3C of *D. n. nasuta* which is polymorphic in nature (NIRMALA & KRISHNAMURTHY, 1974).

It is evident from the present findings that chromosome 2L of *D. n. albomicana* differs from that of *D. n. nasuta* by one fixed inversion NA_1 and chromosome 2L of *D s. sulfurigaster, D. s. bilimbata* and *D. pulaua* differ from that of *D. s. neonasuta* by the same fixed inversion NA_1. Thus

it can be concluded that the gene arrangement in chromosome 2L of *D. n. albomicana, D. s. sulfurigaster, D. s. bilimbata* and *D. pulaua* are same and are the carriers of inversion NA_1 in homozygous condition with respect to standard gene order of *D. n. nasuta*. Further, it is evident that the X chromosome is homosequential in all the members of the subgroup studied.

DISCUSSION

The gene arrangements in the hybrid progeny from a cross between *D. melanogaster* and *D. simulans* were analysed by HORTON (1939), who was able to detect a large inversion in addition to six small ones. These findings correlate with the results of BAUER and DOBZHANSKY (1937) and of MILLER (1939). The present studies of the authors have revealed the presence of two fixed inversions named NA_1, and NA_2 in the hybrid larval salivaries of *D. n. nasuta* and *D. n. albomicana*. Though these are fixed inversions, they are also found in natural populations of both *D. n. nasuta* and *D. s. neonasuta*, though not in *D. n. albomicana*. The inversion NA_1 is similar to 2LB of *D. n. nasuta* and 2LA of *D. s. neonasuta* earlier reported in the natural populations of these species by NIRMALA & KRISHNAMURTHY (1973–74) and RANGANATH & KRISHNAMURTHY (1975).

In the hybrid larvae of *D. n. nasuta* and *D. n. kepulauana*, two fixed inversions NK_1 and NK2 are encountered. Of the two, NK_1 is similar to inversion D_3 of *D.s. albostrigata* reported by MATHER *et. al.*, (1974). From the two crosses thus far discussed, it is clear that *D. n. albomicana* has inversions NA_1 and NA2 and *D. n. kepulauana* has NK_1 and NK2 in homozygous condition with respect to standard gene sequence of *D. n. nasuta*.

The hybrid larvae of these crosses do not share similar fixed inversions. Thus *D. n. albomicana* and *D.n. kepulauana* under study differ from each other by four fixed paracentric inversions; one in chromosome 2R, one in chromosome 2L and two in chromosome 3.

BURLA *et al.*, (1949) compared the gene arrangements in the salivary gland chromosomes of the four cross sterile sibling species of *willistoni* species group, namely *D. willistoni, D. paulistorum, D. tropicalis* and *D. equinoxialis* and denoted that these species differ from one another by a few paracentric inversions and two pericentrics. Perusal of Table 2 reveals that D. *kohkoa* is reproductively isolated from the remaining members under study, thus indicating its closed genetic system with respect to other members of the subgroup. A direct optical comparison of the salivary gland chromosomes of the parental larvae of *D. kohkoa* with that of standard sequence of *D. n. nasuta* (chosen as the basic configuration for the subgroup) revealed that the former differs from the latter species by a paracentric inversion NKo_1 and two three-break shifts or transpositions $NKo\text{–}S_1$ and $NKo\text{–}S_2$ in the chromosome 3. *D. n. albomicana* thus differs from *D. kohkoa* by 3 fixed paracentrics NA_1, NA_2 and NKo_1 and two transpositions while *D. n. kepulauana* differs by 3 fixed paracentrics NK_1, NK_2 and NKo_1 and two transpositions.

The present finding of the occurrence of three-break shifts as species differential is a very interesting feature. DOBZHANSKY has expressed that there are no sure cases of three-break rearrangements in *Drosophila* species (cf. PATTERSON & STONE, 1952). WHITE (1973) has opined that chromosomal repatterning due to transpositions are rare. However FREIRE-MAIA (1961) has reported

three-break shifts in the natural populations of *D. ananassae*. So the present report of involvement of shifts or transpositions in the chromosomal differentiation of the closely related species in the genus *Drosophila* is a unique report of its kind.

The morphologically similar members namely *D. n. nasuta*, *D.n. albomicana*, *D. n. kepulauana* and *D.kohkoa* which are involved in the crosses and optical comparisons discussed so far, belong to frontal sheen complex. It is evident from the present results that even though these members are morphologically similar, chromosomally they are different. Contrary to this are the findings of CARSON (cf. DOBZHANSKY, 1972) on the Hawaiian *Drosophila* in that these endemics are homosequential though they are morphologically quite distinguishable.

D. s. neonasuta is reproductively isolated from all the members of frontal sheen complex, but produces hybrids with *D. s. sulfurigaster*, *D. s. albostrigata*, *D. s. bilimbata* and *D. pulaua*, all of which belong to the orbital sheen complex. In crosses where *D. s. neonasuta* is involved and hybrids are produced, they invariably show the presence of an inversion in chrmosome 2L. This inversion is similar to NA_1 obtained in the hybrid larvae of the cross between *D. n. nasuta* and *D. n.albomicana* which in turn is similar to invesion 2LB and 2LA reported in the natural populations of *D. n. nasuta* and *D. s. neonasuta* respectively. it is interesting to note that eventhough the members of orbital sheen complex are completely isolated from *D. n. albomicana* they share a common inversion, suggesting their probable divergence from a common ancestor. Further, the hybrids of the crosses involving morphologically similar members of orbital sheen complex namely *D. s. sulfurigaster*, *D. s. bilimbata* and *D. pulaua* did not show any chromosomal rearrangements in their salivary gland chromosomes indicating that they are homosequential. The authors thus recognize them as morphologically and chromosomally similar forms.

As the members of frontal sheen complex failed to produce hybrids with any member of orbital sheen complex (Table 2), *D. n. nasuta* and *D. s. neonasuta*; one representative member from each morphophenotypic complex were selected and a direct optical comparison of the salivary gland chromosomes of the parental larvae was made. Such a study revealed that only the chromosome 3 of the latter species differs from that of the former by two fixed inversions NNe_1 and NNe_2. Of these two NNe_2 is similar to the polymorphic inversion 3C of *D. n. nasuta* reported by NIRMALA & KRISHNAMURTHY (1974). In the authors' opinion this differentiation in gene sequence is another change that adds to the morphophenotypic variability of the two complexes.

As the chromosome 3 of *D. s. sulfurigaster*, *D. s. bilmbata* and *D. pulaua* have a similar gene order as that of *D. s. neonasuta*, it is clear that they differ from standard gene arrangement of *D. n. nasuta* by inversions NNe_1, NNe_2 in chromosome 3 and NA_1 in chromosome 2L. Here the authors recognize another type of divergence wherein forms are both morphologically and chromosomally differentiated.

Present investigations revealed chromosomal differentiation only in the chromosomes 2 and 3 while the X chromosome is homosequential in all the members of the subgroup analysed. Similar situation is reported for the X chromosomes in the members of the *D. bipectinata* complex (BOCK, 1971) and in the representatives of the *willistoni*, *saltans* and majority of the *obscura* species group of *Drosophila* (cf. DOBZHANSKY, 1951). But the X chromosomes in the members of *saltans* subgroup

(BICUDO, 1973), *repleta* group (WASSERMAN, 1962a, b, c), *mesophragmatica* species group (BRNCIC *et al.*, 1971) of *Drosophila* have been shown to differ in their gene arrangements.

The X chromosome which is homosequential in the members of *nasuta* subgroup is also reported to be least polymorphic in nature. Only 8 paracentric inversions are reported for X chromosome in 11 members of the subgroup. On the other hand chromosome 2 and 3 are reported to be highly polymorphic (NIRMALA & KRISHNAMURTHY, 1973–74, 1974; RANGANATH & KRISHNAMURTHY, 1975; MATHER & THONGMEEARKOM, 1972, 1973 & MATHER *et al.*, 1974). Based on the present findings of the authors, it is evident that two fixed inversions occur in the chromosome 2 and five fixed inversions in addition to two transpositions are housed in chromosome 3. Thus it is opined that the X chromosome was more stable than others while chromosomes 2 and 3 were accessible for fixing the gene complexes thus contributing for chromosomal differentiation, in the course of evolution of *nasuta* subgroup.

Except for the two transpositions, the members of *nasuta* subgroup under study differ from each other by paracentric inversions while neither pericentrics nor translocations are detected. Similar studies on the *virilis* group (HSU, 1952; STONE *et al.*, 1960), the *repleta* complex (WASSERMAN, 1962a, b, c), the *melanica* group (STALKER, 1965), the *mesophragmatica* group (BRNCIC *et al.*, 1971), the *bipectinata* complex (BOCK, 1971) of *Drosophila* have revealed that the differences existing among the closely related species could be explained by paracentric inversions, while pericentric inversions and translocations are rare.

It has been shown by DOBZHANSKY (1944) and STONE (1962) that structural changes namely inversions and translocations are rare events and the identical gene arrangements found in closely related forms are likely to be of common origin. The fixed inversions encountered in the members of *nasuta* subgroup in the present studies are either exclusive to one species or shared by several. The inversions which are exclusive to one species are NA_2, NK_1, NK_2 and NKo_1. The shared inversions are NA_1 found in *D. n. albomicana*, *D. s. sulfurigaster*, *D. s. bilimbata* and *D. pulaua* while NNe_1 and NNe_2 are shared by morphologically similar members of orbital sheen complex namely *D. s. neonasuta*, *D. s. sulfurigaster*, *D.s. bilimbata* and *D. pulaua*. Further, the latter three differ from *D. s. neonasuta* in possessing inversion NA_1 in homozygous condition. Eventhough *D. n. albomicana* which belongs to frontal sheen complex, shares inversion NA_1 with *D. s. sulfurigaster*, *D.s. bilimbata* and *D. pulaua* but differs from them by three inversions viz., NA_2, NNe_1 and NNe_2. The authors on the above grounds feel that *D. s. sulfurigaster*, *D.s. bilimbata* and *D. pulaua* are nearer to each other than to the other members of the subgroup.

BICUDO (1973) is of the opinion that species with wider distribution and greater polymorphism represents the oldest. In this context, *D. n. nasuta* could be considered as the oldest since it enjoys a wide range of distribution compared to other members of the subgroup (LAMB, 1914; RAY CHAUDHURI and JHA, 1969; WAKAHAMA & KITAGAWA, 1972; NIRMALA & KRISHNAMURTHY, 1974; GUPTA, 1974; RANGANATH & KRISHNAMURTHY, 1975; GOWDA *et al.*, 1977; PRAKASH & REDDY, 1978a, b, c), and harbours a wealth of 44 inversions (NIRMALA & KRISHNAMURTHY, 1974; RANGANATH & KRISHNAMURTHY, 1975; RAJASEKARASETTY & RAMESH, 1977). Thus, the authors are of the opinion that *D. n. nasuta* is probably the oldest and might have been

the ancestor to other members of the subgroup which have diverged during the course of time.

Acknowledgements:—The financial assistance of the Department of Atomic Energy, Government of India, is gratefully acknowledged.

REFERENCES

BAUR, H. & TH. DOBZHANSKY (1937) A comparison of gene arrangement in *Drosophila azteca* and *D. athabasca*. *Genetics*, **22:** 185.

BICUDO, H.E.M.C. (1973) Chromosomal polymorphism in the *saltans* group of *Drosophila*. I. The *saltans* subgroup. *Genetica*, **44:** 520–552.

BOCK, I.R. (1971) Intra and interspecific chromosomal inversions in the *Drosophila bipectinata* species complex. *Chromosoma*, **34:** 206–229.

BRNCIC, D., P.S. NAIR, & M.R. WHEELER (1971) Cytotaxonomic relationships within the *mesophragmatica* species group of *Drosophila*. *Univ. Tex. Publs.*, 7103 : 1–16.

BURLA, H., A.B. DA CUNHA, A. R. CORDEIRO, TH. DOBZHANSKY, C. MALOGOLOWKIN & C. PAVAN (1949) The *willistoni* group of sibling species of *Drosophila*. *Evolution*, **3:** 300–314.

DOBZHANSKY, TH. (1944) Chromosomal races in *Drosophila pseudoobscura* and *Drosophila persimilis*. *Carnegie Inst. Publs.*, 554 : 47–144.

DOBZHANSKY, TH. (1951) *Genetics and the origin of species*. Oxford & IBH Publishing Co., New Delhi, Bombay, Calcutta.

DOBZHANSKY, TH. (1972) Species of *Drosophila*. *Science*, **177**: 664–669.

FREIRE-MALA, N. (1961) Peculiar gene arrangements in Brazilian natural populations of *Drosophila ananassae*. *Evolution*, **15:** 486–495.

GOWDA, L.S., M.R. RAJASEKARASETTY & N.B. KRISHNAMURTHY (1977) Studies on the *Drosophila* fauna of Peninsular India. *Drosoph. Inf. Serv.*, **52:** 35–37.

GUPTA, J.P. (1974) The family Drosophilidae in India. *Indian Biologist*, **5:** 7–30.

HORTON, I.H. (1939) A comparison of the salivary gland chromosomes of *Drosophila melanogaster* and *D. simulans*. *Genetics*, **24:** 234–243.

HSU, T.C. (1952) Chromosomal variation and evolution in the *virilis* group of *Drosophila*. *Univ. Tex. Publs.*, 5204 : 35–72.

LAMB, C.G. (1914) Diptera: Heteroneuridae, Ortalidae, Trypetidae, Sepsidae, Micropezidae, Drosophilidae, Geomyzidae, Milichiidae, of Seychelles. *Trans. Linn. Soc. Lond.*, **16:** 307–372.

MATHER, W.B. & P. THONGMEEARKOM (1972) The *nasuta* complex in Luzon. *Drosoph. Inf. Serv.*, **50:** 60–63.

MATHER, W.B. & P. THONGMEERAKOM (1973) Inversion polymorphism in *D.s. albostrigata*. *Drosoph. Inf. Serv.*, **48:** 40–42.

MATHER, W.B., P. THONGMEEARKOM, M. CLYDE & D. LAMBERT (1974) *D. s. albostrigata* from the Philippines and Western Malaysia. *Drosoph. Inf. Serv.*, **51:** 86–87.

MILLER, D.D. (1939) Structure and variation of the Chromosomes in *Drosophila algonquin*. *Genetics*, **24:** 669–708.

NIRMALA, S.S. & N. B. KRISHNAMURTHY (1972) *Drosophila albomicans* – a race of *Drosophila nasuta*. *Drosoph. Inf. Serv.*, **49:** 60.

NIRMALA, S.S. & N.B. KRISHNAMURTHY (1973–74) Cytogenetic studies on *Drosophila neonasuta* – A member of the *nasuta* subgroup. *J. Mysore Univ.*, **26B** : 162–167.

NIRMALA, S.S. & N. B. KRISHNAMURTHY (1974) Endophenotypic variability in natural populations of *Drosophila* nasuta. *Egypt. J. Genet. Cytol.*, **3:** 211–228.

PATTERSON, J.T. & W.S. STONE (1952) *Evolution in the genus Drosophila*. The Macmillan Company, New York.

PRAKASH, H.S. & G.S. REDDY (1978a) *Drosophila* fauna of Bababudangiri and Kemmangundi hill ranges (Western ghats). *Entomon*, **3:** 85–90.

PRAKASH, H.S. & G.S. REDDY (1978b) *Drosophila* fauna of Sahyadri hills (Western ghats) with description of a new species. *Proc. Indian Acad. Sci.*,

PRAKASH, H.S. & G. S. REDDY (1978c) The genus *Drosophila* in Nagarhole (Western ghats), South India, including description of a new species. *J. Aust. Ent. Soc.*

RANGANATH, H.A. & N.B. KRISHNAMURTHY (1973-74) Chromosomal morphism in *Drosophila nasuta* LAMB. IV. Photomap of salivary gland chromosomes and microdifferentiation in the ploymorphism of Mysore populations. *J. Mysore Univ.*, **26B:** 65–69.

RANGANATH, H.A. & N.B. KRISHNAMURTHY (1975) Chromosomal polymorphism in *Drosophila nausuta*. III. Inverted gene arrangements in South Indian populations. *J. Heredity*, **66:** 90–96.

RANGANATH, H.A. & N.B. KRISHNAMURTHY (1976) Status of *Drosophila neonasuta* in the *nasuta* subgroup. *Egypt. J. Genet. Cytol.*, **5**: 141–145.

RANGANATH, H.A., M.R. RAJASEKARASETTY & N.B. KRISHNAMURTHY (1974) Evolutionary status of Indian *Drosophila nasuta*. *Indian J. Heredity*, **6:** 19–25.

RAJASEKARASETTY, M.R. & S.R. RAMESH (1977) On the occurrence of new inverted gene arrangement in *Drosophila nasuta nasuta*. *Drosoph. Inf. Serv.*, **52:** 122.

RAY CHAUDHURI, S.P. & A.P. JHA (1969) Evolutionary status of *Drosophila nasuta*. *Nucleus*, **12:** 9–13.

STALKER, H.D. (1965) The salivary chromosomes of *Drosophila micromelanica* and *Drosophila melanura*. *Genetics*, **51:** 487–507.

STONE, W.S. (1962) The dominance of natural selection and the reality of superspecies (Species groups) in the evolution of *Drosophila*. *Univ. Tex. Publs*, 6205 : 506–537.

STONE, W.S., W.C. GUEST & F.D. WILSON (1960) The evolutionary implications of the cytological ploymorphism and phylogeny of the *virilis* group of *Drosophila*. *Proc. natn. Acad. Sci., U.S.A.*, **46** 350–361.

WASSERMAN, M. (1962a) Cytological studies of the *repleta* group of the genus *Drosophila*. VI. The *hydei* subgroup. *Univ. Tex. Publs*, 6205: 73-83.

WASSERMAN, M. (1962b) Cytological studies of the *repleta* group of the genus *Drosophila*. V. The *mulleri* subgroup. *Univ. Tex. Publs.*, 6205 : 85–117.

WASSERMAN, M. (1962c) Cytological studies of the *repleta* group of the genus *Drosophila*. III. The *mercatorum* subgroup. *Univ. Tex. Publs.*, 6205: 63–71.

WHITE, M.J.D. (1973) *Animal Cytology and Evolution*. Cambridge Univ. Press, London.

WILSON, F.D., M.R. WHEELER, M. HARGET & M. KAMBYSELLIS (1969) Cytogenetic relations in the *Drosophila nasuta* subgroup of the *immigrans* group of species. *Univ. Tex. Publs.*, 6918 : 207–253.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 13 *to* 18

CHROMOSOME NUMBER, SEX CHROMATIN AND SEX CHROMOSOME MECHANISM IN SOME SATURNIID MOTHS OF INDIA

M. L. GUPTA & R. C. NARANG
Department of Zoology, University of Jodhpur, Jodhpur, India 342 001

(*Received 26 October 1979*)

The chromosome number and sex chromatin have been studied in 8 species of saturniids. Inter-populational ploymorphism regarding chromosome number has been discovered in *Philosamia cynthia ricini*; the Titabar population (2n = 28) has XX ♂ : XY ♀ system; the Borduar-Dhenubhanga population (2n ♂ = 28; 2n ♀ = 27) has XX ♂ : XO ♀ system. A constancy in the chromosome number (2n = 98) of a few individuals of *Antheraea roylei* - *A. pernyi* hybrid has been recorded. The subjects of chromosome number and sex chromatin have been discussed.

(*Key words*: **chromosome number, sex chromatin, chromosome mechanism, saturniid moths**)

INTRODUCTION

Though the chromosome number of over 1000 species of Lepidoptera including about twenty five saturniid species has been reported (see TRAUT & MOSBACHER, 1968; ROBINSON, 1971; ENNIS, 1976; NARANG & GUPTA, 1979a, b,d), most of the reports deal with the metaphase I count in the males. The study for sex chromatin in majority of lepidopterans investigated has been made by TRAUT & MOSBACHER (1968), in 82 species, and ENNIS (1976), in 103 Canadian species. In Saturniidae, investigations for it have hitherto been made only in six species (CHOWDHURY & BHUYAN, 1962; TRAUT & MOSBACHER, 1968; ENNIS, 1976). The sex chromosome mechanism in Lepidoptera is generally XX ♂ : XY ♀ but a few cases with XX ♂ : XO ♀ and XX ♂ : $XY_1 Y_2$ ♀ have also been reported (see SMITH, 1945; SUOMALAINEN, 1969b; WHITE, 1973; ENNIS, 1976). In saturniids the sex chromosome mechanism has so far been indicated in *Philosamia cynthia* and *Philosamia cynthia ricini* as XX ♂ : XY ♀ by TRAUT & MOSBACHER (1968) and NARANG & GUPTA (1979c) respectively. The details of karyotype, sex chromosome mechanism and meiosis in most of the saturniids are yet to be studied. The present paper includes investigations regarding chromosome number, sex chromosome mechanism and sex chromatin in 8 saturniid species belonging to 6 genera.

MATERIALS AND METHODS

The species worked out were collected from different parts of north-eastern states of India (Table 1). The larvae (2nd to 5th instar) and their pupae constituted the material for the cytogenetical studies. Smear preparations of gonadal and somatic tissues were made by the method described elsewhere (NARANG & GUPTA, 1979a). The examination of the sex chromatin was made in the various tissues namely germ cells, nerve cells, fat bodies, gut epithelium, Malpighian tubles and silk gland cells.

RESULTS

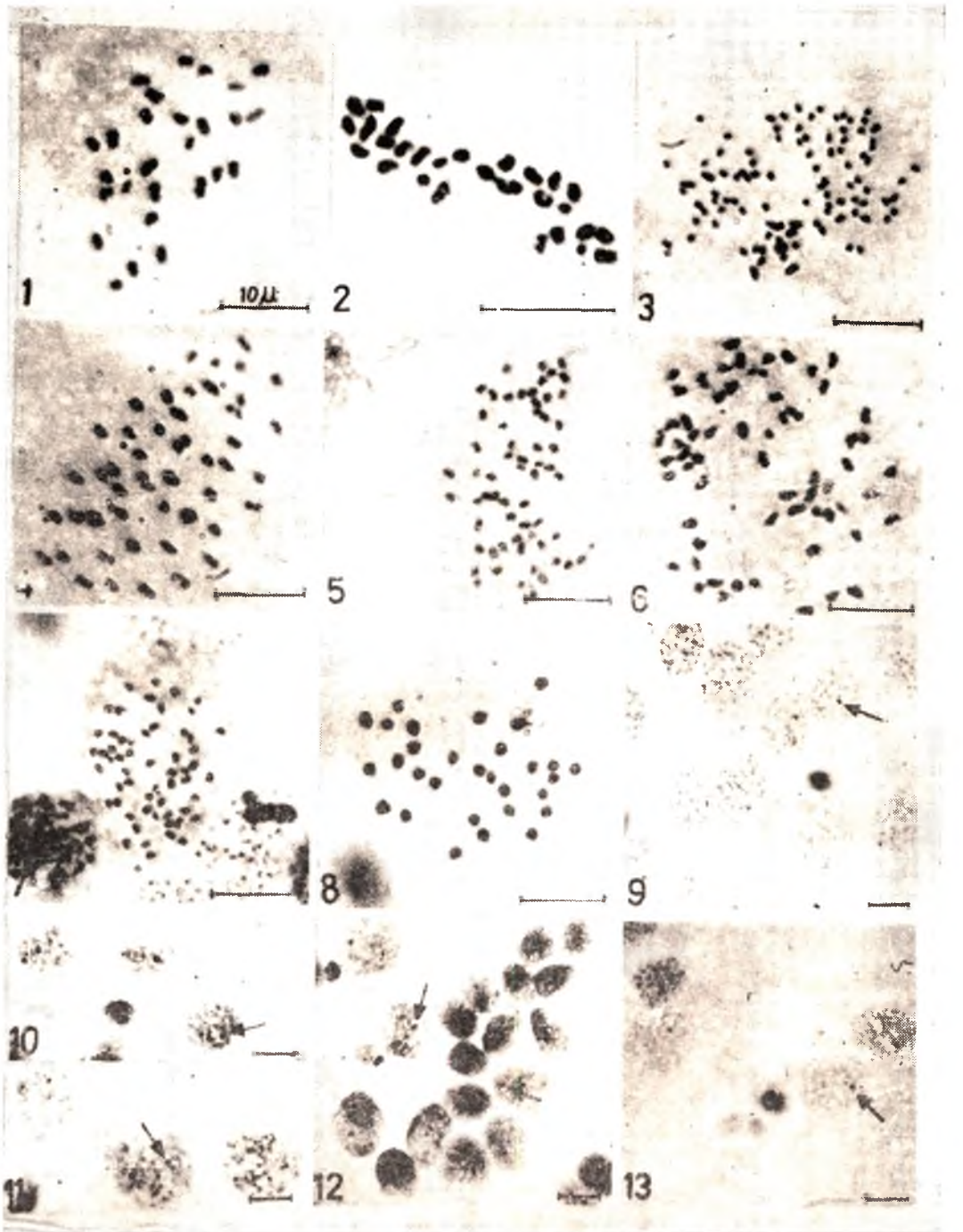
The present findings on chromosome number and sex chromatin in 8 species have been given in Table 1.

The chromosome numbers in males of all the species have been established at

TABLE 1 Sex chromatin and chromosome numbers in saturniids.

Species	Locality	Sex chromatin		Chromosome number			
				Male		Female	
		Male	Female	Meiosis I	Mitosis 2n	Meiosis I	Mitosis 2n
Actias selene HUB.	Ranchi (Bihar)	–	–	31a (II)	62		
Antheraea assamensis WW.	Khanapara (Assam)	–b	–b	15c (II)	30		
Antheraea mylitta DRURY	Ranchi (Bihar)	—	+	31d (II)	62		
Cricula trifenestrata HELF.	Khasi Hills (Meghalaya)	–	+	31e (II)	62e		
Dictyoploca cachara MR.	–do–	--	+	30f (II)	60f		
Loepa katinka WW.	–do–	–	+	28g (II)	56		
Philosamia cynthia canningii HUTT.	–do–	–	—	14h (II)	28h		
Philosamia cynthia ricini	Titabar (Assam)	–b	–b	14i (II)	28i	14i (II)	28i
	Borduar & Dhenubhanga	—	—	14 (II)	28	13 (II) + 1 (I)	27
Antheraea roylei-Antheraea pernyi, hybrid	Labang (Assam)	–	+	30–49j (I), (II), (III), 49 (II)	98		

a, DEODIKAR *et al.* (1969); b, CHOWDHURY & BHUYAN (1962); c, DEODIKAR *et al.* (1962); d, SINHA & JOLLY (1967); e, NARANG & GUPTA (1979a); f, NARANG & GUPTA (1979b); g, NARANG & GUPTA (1979d); h, NARANG & GUPTA (1979e); i, NARANG & GUPTA (1979c); j, JOLLY *et al.* (1973).
+ present; – absent; (I) univalent; (II) bivalent; (III) trivalent.



Figs. 1–8: Mitotic and meiotic chromosomes. Fig. 1. *Philosamia cynthia ricini* ♀ (2n = 27). Fig. 2. *P. c. ricini* ♂ (2n = 28). Fig. 3. *Antheraea roylei* - *A. pernyi* hybrid ♂ (2n = 98). Fig. 4. *A. roylei* - *A. pernyi* hybrid ♂ (n = 49). Fig. 5. *Actias selene* ♂ (2n = 62). Fig. 6. *Antheraea mylitta* ♂ (2n = 62). Fig. 7. *Loepa katinka* ♂ (2n = 56). Fig. 8. *Antheraea assamensis* ♂ (2n = 30). Figs. 9–13: Sex chromatin (arrows) in germ (G) and brain (B) cells in females. Fig. 9. *Loepa katinka* (B). Fig. 10. *Cricula trifenestrata* (G). Fig. 11. *Antheraea mylitta* (B). Fig. 12. *Dictyoploca cachara* (G). Fig. 13. *Antheraea roylei* - *A. pernyi* hybrid (G).

mitotic stages, and meiotic II stage in a few cases, besides the usually studied meiotic I cells. Such information in females, of the species studied is, however, still incomplete. In a population of *P. c. ricini* from Borduar and Dhenubhanga (Assam), we observed an odd chromosome number (2n=27, Fig. 1) in females and even number (2n=28, Fig. 2) in males, whereas Titabar (Assam) population of this race has even number (2n=28) in both the sexes. The chromosome number of the former has been determined in 10 females and 20 males and of the latter in several individuals. In a population of the fertile hybrid of *Antheraea roylei* and *A. pernyi* (produced originally at Central Tasar Research Station, Ranchi by JOLLY *et al.*, 1973), from Labang (Assam), a constancy of chromosome number (2n=98) has been discovered in a study of 11 mitotic cells (Fig. 3) and 4 meiotic cells (Fig. 4) from as many as seven individuals. The chromosome numbers in rest of the species studied conform to those of earlier findings. The diploid number of chromosomes in mitotic stage of *Actias selene* (Fig. 5), *Antheraea mylitta* (Fig. 6) *Loepa katinka* (Fig. 7) and *Antheraea assamensis* (Fig. 8) have been reported for the first time.

The sex chromatin has been found to be present in females of the four species and *A. roylei*—*A. pernyi* hybrid out of the eight species investigated (Table 1) in the germ cells and brain cells, examined in all of them, besides silk gland cells, gut epithelium and Malpighian tubules examined in a few of them. The sex chromatin appears as a single, almost spherical, condensed and positively heteropycnotic body in interphase and early prophase stages in majority of the cells studied at the pupal stage of the species and also in the larval stages examined in *A. mylitta* and *A. roylei*—*A. pernyi* hybrid.

The sex chromosome mechanism has been determined in *P. c. ricini*. The Titabar population of this species having diploid number as 28 in both the sexes has XX♂: XY♀ sex chromosome mechanism; the identi- fication of sex chromosomes has already been reported (NARANG & GUPTA, 1979c). The other population of this species from Borduar and Dhenubhanga (Assam), characterized by loss in females of a chromosome (probably the Y) from the normal complement, has XX♂: XO♀ system.

DISCUSSION

The chromosome number in saturniids is now known for 25 species belonging to 13 genera (see ROBINSON, 1971; ENNIS, 1976; NARANG & GUPTA, 1979a,b,d). The haploid numbers reported so far range from 13 in *P. cynthia* to 49 in *A. pernyi*, with 31 as a probable modal number (NARANG & GUPTA, 1979a). For the first time, an intraspecific chromosomal polymorphism has been discovered in *P. c. ricini*: the variation is interpopulational and in female sex only—the Titabar population having 2n=28 and the Borduar—Dhenubhanga population having 2n=27, the lost chromosome in the latter being the Y of the usual XY♀ sex chromosome mechanism (NARANG & GUPTA, 1979c). The hybrid of *A.* roylei and *A. pernyi*, named as a new species, *A. proylei* JOLLY (JOLLY *et al.*, 1973; JOLLY, 1976), reveals 30 elements at metaphase I in males in F_1 generation, but the number of such elements varies from 32 to 49 in the F_2 and back cross individuals (JOLLY *et al.*, 1973). The hybrid has been reared by selfmating for the last several years and the stock was reported to have reached 20th generation in 1976 (JOLLY, 1976). The population of it from Labang investigated cytogenetically by us might have evolved a constant chromosome number i.e., 2n=98 as this number has been recorded invariably in

seven male individuals, though the number of available cells studied is only fifteen. It is however, necessary to confirm this point by further studies. TAZIMA (1974) put forward the view that the increased number of chromosomes of *A. pernyi* evolved from the chromosomes of *A. roylei* by splitting because F_1 hybrid shows complete pairing of the chromosomes of both the species and has invariably 30 elements (bivalents and trivalents) at metaphase I. The remarkable fertility of *A. roylei—A. pernyi* hybrids, despite the variable chromosome number known to be existing so far (JOLLY *et al.*, 1973), further shows closeness of *A. roylei* with *A. pernyi*. Since the population of hybrids is a mixed one having variant chromosome numbers and is existing sympatrically with *A. roylei* without attaining reproductive and/or ecological isolation from the latter, its status as a new species seems to be doubtful.

TRAUT & MOSBACHER (1968) and ENNIS (1976) reported the sex chromatin in the somatic tissues of the females of many lepidopteran species studied and interpreted this female specific heterochromatin to represent the Y. BIGGER (1975) reported sex chromatin in germ cells of the females of 3 species of butterflies, and on comparison of its morphology with that of the sex chromosomes, interpreted it to be the X. However, the acceptance of BIGGER'S interpretation should await the sex chromatin study in the somatic tissues as well.

Sex chromatin in saturniids has already been reported to be present in somatic tissues of only the females of four species, *viz. P. cynthia* (TRAUT & MOSBACHER, 1968), *Actias luna, Automeris io* and *Dryocampa rubicunda* (ENNIS, 1976) and absent in both the sexes of *P. c. ricini* and *A. assamensis* (CHOWDHURY & BHUYAN, 1962) and *Anisota senatoria* (ENNIS, (1976). In the present study, the sex chromatin has been found to be present in germ as well as somatic cells of only the females of *L.katinka*, (Fig. 9), *Cricula trifenestrata* (Fig. 10), *A. mylitta* (Fig. 11), *Dictyoploca cachara* (Fig. 12) and *A. roylei–A. pernyi* hybrid (Fig. 13), whereas it is absent in both the sexes of *P. c. ricini, P. c. canningii, A. assamensis* and *A. selene*. The sex chromatin, present only in females of the above species, is probably the Y–chromatin as interpreted by earlier workers (*vide supra*). The available information regarding the presence of sex chromatin in saturniids shows an interspecific variation in the genera *Actias* and *Antheraea* and intraspecific variation in *P. cynthia*. As such further investigations on the sex chromatin as well as on the karyotype in more species of different genera of Saturniidae are warranted.

Acknowledgements:—The authors wish to express their gratitude to Prof. S.D. MISRA, Head of the department, for laboratory facilities and encouragement, and to Mr. S.K. SIRCAR, Naturalist, Meghalaya, for supplying the cocoons of some of the species. The award of UGC Teacher Fellowship to one of the authors (RCN) is also gratefully acknowledged.

REFERENCES

BIGGER, T.R.L. (1975) Karyotype of some Lepidoptera chromosomes and changes in their holokinetic organization as revealed by new cytological techniques. *Cytologia*, **40**: 713–726.

CHOWDHURY, S.N. & B.N. BHUYAN (1962) Preliminary note on artificial heat parthenogenesis in Assamese silkworm, *Antheraea assama*. *IInd A.I. Cong. Zool., Varanasi* (Abstract) 58.

DEODIKAR, G.B., S.N. CHOWDHURY, B.N. BHUYAN & K.K. KSHIRSAGAR (1962) Cytogenetic studies in Indian silkworms. II. Chromosome number in Muga silk-worm, *Antheraea assamensis* Ww. *Curr. Sci.*, **31**: 247–248.

DEODIKAR, G.B., K.K. KSHIRSAGAR & I.A. KAMATE (1969) Chromosome number in *Actias selene* HUB.—a wild silkworm with reelable cocoons. *Ind. J. Genet. Plant Breeding*, **29**: 126–130.

ENNIS, T.J. (1976) Sex chromatin and chromosome numbers in Lepidoptera. *Can. J. Genet. Cytol.*, **18**: 119–130.

JOLLY, M.S., R.R. BAKSHI & S.S. SINHA (1973) Interspecific hybridization in *Antheraea* (Lepidoptera, Saturniidae) with special reference to *A. roylei* MR. and *A. pernyi* G.M. *XII. Int. Silk Congr.*, Barcelona.

JOLLY, M.S. (1976) Comments on 'A review of the taxonomic status of the hybrids with particular reference to *Antheraea proylei* JOLLY (Lepidoptera. Saturniidae)'. *Ind. J. Seri.*, **15** (1): 49–50.

NARANG, R.C. & M.L. GUPTA (1979a) Chromosome number of *Cricula trifenestrata* HELFER (Lepidoptera: Saturniidae). *Curr. Sci.*, **48** (10): 465–466.

NARANG R.C. & M.L. GUPTA (1979b) Chromosome number of wild silkmoth, *Dictyoploca cachara* MOORE (Saturniidae, Lepidoptera. *Nat. Acad. Sci.*, Letters **2** (5): 201.

NARANG, R.C. & M.L. GUPTA (1979c) Chromosomal studies in eri silkmoth *Philosamia ricini* HUTT. (Lepidoptera: Saturniidae). *Entomon*, **4** (3): 217–221.

NARANG, R.C. & M.L. GUPTA (1979d) Note on the chromosomes of a wild silkmoth, *Loepa katinka* WESTWOOD (Lepidoptera: Saturniidae). *Chromo. Inf. Serv.*, **26**: 17–18.

NARANG, R.C. & M.L. GUPTA (1979e) Chromosome set of a wild silkmoth, *Philosamia cynthia canningii* HUTT. (Lepidoptera: Saturniidae). *Chromo. Inf. Serv.*, (unpublished).

ROBINSON, R. (1971) *Lepidoptera Genetics*. Pergamon Press, Toronto.

SINHA, S.S. & M.S. JOLLY (1967) Chromosome number in Tasar silk worm, *Antheraea mylitta* DRURY. *Curr. Sci.*, **36** (13): 359.

SMITH, S.G. (1945) The diagnosis of sex by means of heteropycnosis. *Sci. Agric.*, **25**: 566–571.

SUOMALAINEN, E. (1969b) On the sex chromosome trivalent in some Lepidoptera females. *Chromosoma*, **28**: 298–308.

TAZIMA, Y. (1974) A view on chromosome behaviour in an inter-specific hybrid *A. roylei* × *A. pernyi*. *Proc. Ist. Int. Sem. Non-Mulberry Silks*, 51–52.

TRAUT, W. & G.C. MOSBACHER (1968) Geschlechtschromatin bei Lepidopteren. *Chromosoma*, **25**: 343–356.

WHITE, M.J.D. (1973) *Animal Cytology and Evolution*. 3rd ed., Cambridge Univ. Press, London.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 19 *to* 23

PREREDUCTIONAL MEIOSIS IN AN XO MALE REDUVID BUG, *ECTRYCHOTES ABBREVIATUS* REUT. (HETEROPTERA)

G. K. MANNA & S. DEB-MALLICK
Department of Zoology, University of Kalyani, Kalyani, West Bengal, India 741 235

(*Received 10 November 1979*)

Heteropteran insects have characteristically postreductional meiosis. Further the reduvid group possess relatively high diploid number and having mostly multiple X chromosomes but the single Y. Exceptional to these, the reduvid bug, *Ectrychotes abbreviatus* under present report has been found to have XO males with prereductional meiosis. The behaviour of the sex chromosome during meiosis has been described and compared with that of a congeneric species and its mode of origin has been suggested. This sex mechanism possibly characterizes the genus if not the subfamily Ectrychotinae.

(*Key words:* **prereductional meiosis, XO male, reduvid,** *Ectrychotes abbreviatus*)

INTRODUCTION

Broadly about 800 species of Heteroptera are cytologically known so far (MANNA, 1951, 1958, 1962 and unpublished; TAKENOUCHI & MURAMOTO, 1969; WHITE, 1973) among which, barring one or two doubtful cases (see MAKINO, 1956), authentic records on prereductional meiosis in XO males have been made only in *Archimerus calcarator* (WILSON, 1905a, b, 1909) and *Pachylis gigas* (SCHRADER, 1932) belonging to the family Coreidae and in *Ectrychotes dispar* (MANNA, 1951) belonging to the family Reduviidae. Therefore, the prereductional meiosis reported here in the congeneric species *E. abbreviatus* happened to be the second instance in Reduviidae and possibly the fourth instance in Heteroptera. It has thrown further light in the cytotaxonomical evaluation of Heteroptera (MANNA, 1958, 1962). Prereductional meiosis in species with XY males are equally rare and it seemed to be characteristically present in Tingidae (MANNA, 1962) and possibly in one species of *Lethocerus* under the family Belostomatidae. However, so far no report of the prereductional meiosis in any species of Heteroptera with multiple sex chromosomes has been published though a number of families have predominantly multiple sex determining mechanism (MANNA 1962).

MATERIALS AND METHODS

Two adult males of *Ectrychotes abbreviatus* REUT (Ectrychotinae, Reduviide, Heteroptera) were collected near the electric lamp in a room at night and their testes were fixed separately in acetic-alcohol mixture (1:3). The fixed tissue was put into 45% acetic acid for a minute and then squahed between a cover-glass and a slide smeared with albumin and dried before use. After squashing by the thumb pressure under cover of filter paper the slide was dried periodically by passing quickly over a gentle flame and after about an hour it was immersed into a jar of 50% alcohol for the detachment of the cover-glass. The slide was then passed through lower grades of alcohol to water. It was mordanted in 3% iron-alum solution, stained in 1% haematoxylin solution and differentiated in aqueous solution of picric acid. The slide was thoroughly washed in running water, dehydrated in upgrades of alcohol, cleared in xylol and mounted in euparol. Each specimen contained plenty of spermatocytic stages but very few spermatogonial metaphases.

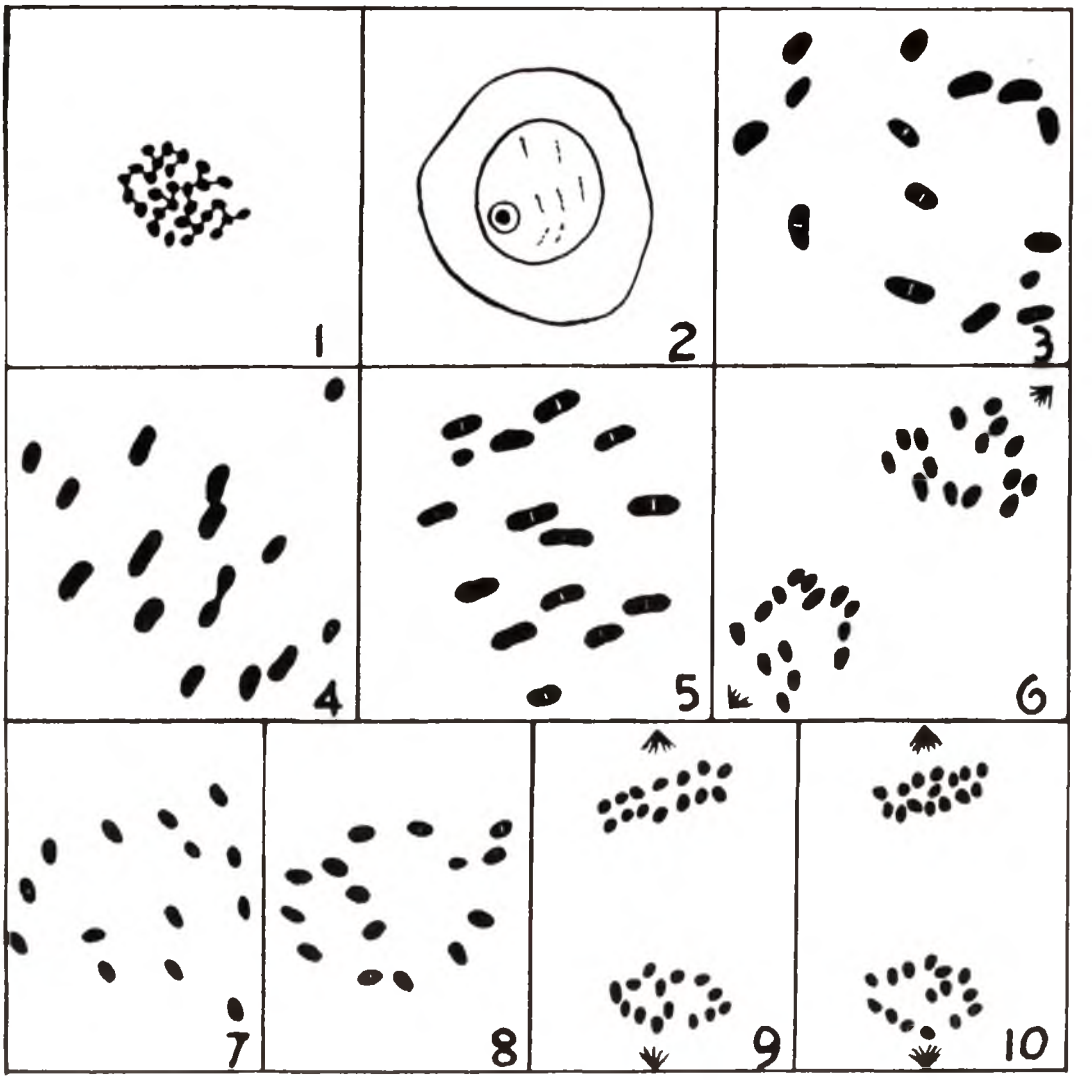
OBSERVATIONS

The spermatogonial metaphase contained somewhat closely packed 29 minute chromosomes, some with thin thread-like interconnections (Fig. 1). The chromosomes could neither be put into different size-groups nor any one of them could individually be demarcated. The zygotene-pachytene nuclei of the primary spermatocytic prophase contained a small positively heteropycnotic body representing possibly the X chromosome associated with a nucleolus, sometimes completely embedded within it while autosomal pairs represented by faintly stained dispersed chromatin elements showed no regular visible structure (Fig. 2). From late diplotene and diakinesis 14 bivalents with somewhat fuzzy outlines and a single chiasma and a slightly deeply stained univalent X chromosome could be seen. At late diakinesis and prometaphase I, 14 rod-like bivalents became clear and the sex chromosome hardly showed any staining difference (Fig. 3). The bivalents underwent maximum condensation at metaphase I when 14 autosomal bivalents arranged within the spindle in the equatorial region while the bipartite relatively small univalent X chromosome was forming an accessory plate near the poleward region (Fig. 4) or lying anywhere in the spindle even with the bivalents (Fig. 5). That the X chromosome might undergo reduction division being incorporated into one of the daughter nuclei was indicated by its free disposition which could be compared with that of the X chromosome of short-horned grasshopper at metaphase I (MANNA, 1967). First division anaphase was reductional for the autosomes and the X chromosome as a result of which two types of daughter nuclei could be traced (Fig. 6), one containing 14 autosomes only and the other half contained 14 autosomes plus the undivided single X making a total of 15 elements. The X chromosome at this stage could sometimes be identified by its anomalous movement in comparison to the separating autosomes. This was possible mostly at the beginning of anaphase I. As the first division was reductional, two types of second division metaphases, one with 14 autosomes only (Fig. 7) and the other with 15 (14 autosomes + the X) could clearly be demarcated (Fig. 8). However, the X in the latter plate could hardly be identified among 14 autosomes. The second division was equational for the chromosomes as a result in few favourable plates of anaphase II, 14 chromosomes in each daughter half (Fig. 9) and in other type 15 chromosomes in each daughter half could be counted (Fig. 10).

DISCUSSION

A comparison of the chromosomes and their behaviour during spermatogenesis of the present species with that of *E. dispar* reported ealier by MANNA (1951) did not reveal any significant difference and/or deviation. Therefore, no cytological demarcation between two congeneric species of *Ectrychotes* was possible because of the limitation afforded by the minute size of the chromosomes and they were holocentric and also showing the same number and behaviour. The two species must be very closely related.

The cytological characterizations of the family Reduviidae made by MANNA (1962) related that the family constituted a heterogeneous group having relatively high diploid number with the number of autosomes ranging narrowly between 10 and 14 pairs except the conflicting claim of $2n = 14$ by JANDE (1960) and 12 by BANERJEE (1958) in *Polididus armatissimus*, highly variable sex chromosome mechanisms from XO to multiple XS but the single Y and the



Camera lucida drawings × ca. 2000. Fig. 1. Spermatogonial metaphase with 29 chromosomes; Fig. 2. Zygotene stage showing a deeply stained small body sorrounded by a nucleolus possibly the X chromosome; Fig. 3. Prometaphase I with 14 bivalents having single terminalized chiasma while the relatively small bipartite element is the X; Fig. 4. Metaphase I, 14 rod-like bivalents at the equatorial region while the X is polarized; Fig. 5. Metaphase I, 15 elements including the X at the equatorial region of the spindle; Fig. 6. Anaphase I, two daughter nuclei containing 14 and 15 chromosomes; Fig. 7. Metaphase II showing 14 autosomes; Fig. 8. Metaphase II showing 15 chromosomes including the X; Fig. 9. Anaphase II each daughter half with 14 chromosomes; Fig. 10. Anaphase II, each daughter half with 15 chromosomes including the X.

arrangement of bivalents in metaphase I less regular than in metaphase II. The present species indicated a number of deviations as pointed below. Both the species of *Ectrychotes* like *Microtomus conspicillaris* of Microtominae (PIZA, 1957) have the same highest number of 28 autosomes but they differed in sex chromosome mechanism, the latter have XY males. Since the size of the autosomes appeared little smaller than that of other reduvids, it is suggested that fragmentation or dissociation played the role in achieving higher number or *vice versa* in this group.

According to the list prepared by WHITE (1973) some 38 species plus the present one belonging to 24 genera and 8 subfamilies in Reduviidae have been cytologically investigated of which 27 species have multiple sex determining mechanisms. However, except Ectrychotinae and Triatominae in all other subfamilies at least some species if not all (Apiomerinae & Microtominae) have XY males. It has been suggested that in the evolution of multiple sex chromosome mechanisms of Heteroptera and Reduviidae, the fragmentation or dissociation of the original X element took place more often because the autosomal number in species with multiple sex chromosomes remained fairly constant (MANNA, 1962; WHITE, 1973). This was more apparent in Harpactorinae, Piratinae and Stenopodinae. WHITE (1973) further opined that X–autosome fusion has not played any role in the evolution of multiple sex chromosomes in Heteroptera.

The evolution of the sex chromosome mechanism in *Ectrychotes* took a different path. Since XY have been suggested to be the original sex chromosome pattern differentiated from a pair of autosomes during course of evolution, they would normally have the prereductional meiosis (MANNA & CHATTERJEE, 1963). In Heteroptera, species with prereductional XY sex mechanism are on record in the family Tigidae and in some speies of Belostomatidae. As majority of Heteropteran species have post-reductional meiosis, WHITE (1973) considered the cases of prereductional meiosis in some species of Heteroptera as reversion while we hold different view as they could be original retention of the mechanism. Any how if the pereductional meiosis in Heteroptera was taken to be reversion, in the evolution of sex mechanism of two species *Ectrychotes* two steps are to be considered, firstly the reversion of prereductional XY mechanism followed by the the loss of the Y chromosome leading to the establishment of the prereductional XO males. In support of this view it might also be suggested that in no case species with multiple sex chromosomes in Heteroptera has been found to have prereductional meiosis. Therefore, the cytological study of *E. abbreviatus* led us to suggest that the genus and possibly the subfamily Ectrychotinae could be characterized by the presence of highest number of autosomes, and prereductional XO mechanism among Reduviidae. The subfamily as compared to others was very much specialized.

REFERENCES

BANERJEE, M.R. (1958) A study of chromosomes during meiosis in twenty eight species of Hemiptera (Heteroptera, Homoptera). *Proc. zool. Soc., Calcutta*, **11**: 9–37.

JANDE, S.S. (1960) Chromosome mechanism in *Polididus armatissimus* (Reduviidae, Heteroptera). *Experientia*, **16**: 440.

MAKINO, S. (1956) *A review of Chromosome Numbers in Animals* (Revised edition). Tokyo, Hokuryukan Publ. Co.

MANNA, G.K. (1951) A study of chromosomes during meiosis in forty three species of Indian Heteroptera. *Proc. zool. Soc. Beng.*, **4**: 1–116.

MANNA, G.K. (1958) Cytology and inter-relationships between various groups of Heteroptera. *Proc. Xth Internat. Congr. Entomol., Montreal*, **2:** 919–934.

MANNA, G.K. (1962) A further evaluation of the cytology and interrelationships between various groups of Heteroptera. *Nucleus*, **5:** 7–28.

MANNA, G.K. (1967) Cytological analysis of the sex chromosomes from testis cells of grasshopper —a review. *Nucleus*, **10:** 140–158.

MANNA, G.K. & K. CHATTERJEE (1963) Polymorphic sex chromosomes in *Euprepocnemis* sp. I. The meiosis in the XO type male and in the neo-X and neo-Y type male. *Nucleus*, **6:** 121–134.

PIZA, S. DE T. (1957) Comportamento dos cromossomios na espermatogenese de *Microtomus conspicillaris* (DRURY). *Rev Agric.*, **32:** 53–64.

SCHRADER, F. (1932) Recent hypothesis on the structure of spindles in the light of certain observations in Hemiptera. *Z. wiss. Zool.*, **142:** 520–539.

TAKENOUCHI, Y. & N. MURAMOTO (1969) Chromosome numbers of Heteroptera. *J. Hokkaido Univ. Educ.*, **20:** IIB. 1–15.

WHITE, M.J.D. (1973) *Animal Cytology and Evolution* Third Edition. Cambridge University Press.

WILSON G.B. (1905a) Studies on chromosomes. I. The behaviour of idiochromosomes in Hemiptera. *J. exp. Zool.*, **2:** 371–405.

WILSON, G.B. (1905b) Studies on chromosomes. The paired microchromosomes, idiochromosomes and heterotrophic chromosomes in Hemiptera. *Z. exp. Zool.*, **2:** 507–545.

WILSON, G.B. (1909) Studies on chromosomes. IV. The accessory chromosome in *Syromastes* and *Pyrrhocoris*, with a comparative review of the types of sexual difference of the chromosome groups. *Z. exp. Zool.*, **6:** 69–99.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 25 *to* 29

NUCLEIC ACIDS AND PROTEIN SYNTHESES IN THE ACCESSORY GLANDS OF ADULT MALE *AEDES AEGYPTI*

VIMLA ADLAKHA & M. K. K. PILLAI
Department of Zoology, University of Delhi, Delhi, India 110 007

(*Received 10 November 1979*)

Biosynthesis of nucleic acids and proteins in the male accessory glands of the adult *Aedes aegypti* was followed by using ^{3}H-thymidine, ^{3}H-uridine and ^{3}H-lysine as precursors. Incorporation studies show that DNA synthesis was maximal in 6 hr old adults, while RNA synthesis showed a peak at 12 hr. Maximum protein synthesis occurred in 24 hr old adult glands. Synthesis of proteins is almost completed in 2 day old adult mosquito which had become sexually mature.

(*Key words* : **biosynthesis, nucleic acids, proteins, accessory glands, adult male *Aedes aegypti***)

INTRODUCTION

There is now abundant evidence that the accessory gland substance transferred during mating is of great importance to the reproductive physiology of the female mosquito (LEAHY & CRAIG, 1965; CRAIG, 1967; DOWNE, 1975; ADLAKHA & PILLAI, 1975, 1976). The accessory glands rapidly develop from small rudiments to mature full grown glands within 2 days of adult emergence in the yellow fever mosquito, *Aedes aegypti* (L.) (DAPPLES *et al.*, 1974; ADLAKHA *et al.*, 1976). But details of the biosynthesis of the secretory material of accessory glands have not yet been studied in mosquitoes. The fact that initial copulatory capacity of the male mosquitoes appears to be related to the synthesis and storage of the accessory secretion makes this organ of further interest from the biochemical point of view. Also, the accessory gland substance in *Ae. aegypti* is known to consist predominantly of protein or polypeptides (FUCHS *etal.*, 1969; FUCHS & HISS, 1970). Our investigation aimed to study the rate of biosynthesis of nucleic acids and proteins in the male accessory glands of the newly emerged adults of *Ae. aegypti*.

MATERIALS AND METHODS

The mosquitoes used for the present study were taken from a Delhi strain of *Ae. aegypti* maintained at 28°C and 80% RH in an insectary (ADLAKHA & PILLAI, 1975). The syntheses of DNA, RNA and proteins in the male accessory glands were studied *in vivo* for 2 days from the time of adult emergence. Males at different intervals after emergence were lightly ether-anesthetized and injected with appropriate labelled precursors by means of a Hamilton microsyringe through the ventral side between the 4th and 5th abdominal segments. The material was directly injected into the vicinity of the accessory glands. Care was taken not to injure the intestine during injection. The mosquitoes on recovery were left in cages and were fed on glucose solutions. Injections caused about 20% to 30% mortality.

For estimating DNA synthesis adult mosquitoes were injected with 0.12 μCi of ^{3}H-thymidine (Sp. activity 10,600 mCi/mM, supplied by BARC, India) at different time intervals and were sacrificed 1 hr after the injections. Similarly for RNA synthesis mosquitoes were injected with 0.12 μCi of ^{3}H-uridine (Sp. activity 5,500 μCi/mM, BARC, India) Accessory glands of 10 mosquitoes (10 pairs) were dissected out and pooled together. The glands were washed several times in insect Ringer, homogenized and precipitated in cold 5% TCA and left overnight for complete precipitation of proteins in a refrigerator. The precipitate was washed twice with 5% TCA. TCA containing nucleic acids was sprayed evenly on a Whatman No. 1 filter paper disc (2 cm diam.) using a Hamilton microsyringe and the discs were dried with a hair drier and intro-

duced into a scintillation vial with the sprayed surface up. Then 5 ml of scintillation fluid containing 5 g of PPO (2,5–diphenyl oxazol), 0.5 g POPOP (1,4–bis-2–5–phenyl-oxazolyl benzene) in 1 litre of redistilled toluene, was added to the vial and the radioactivity was determined in a Packard Tricarb Liquid Scintillation Spectrometer. Counts of radioactivity of the total supernate are assumed to indicate complete incorporation of precursors into nucleic acids, though DNA and RNA were not specifically separated to demonstrate the same. The counts were corrected to background activity individually. In each estimation four replicates with each having 10 pairs of glands were used. The results are expressed as cpm per pair of accessory glands. In each case mean ± SE have been calculated as shown in Figs. 1 & 2.

Male mosquitoes of different age groups were injected with 0.3 μCi of ^{3}H–lysine (Sp. activity 60.0 mCi/mM supplied by BARC, India) per mosquito to study protein synthesis. After 1 hr the accessory glands were dissected out and processed for protein precipitation as described earlier. The

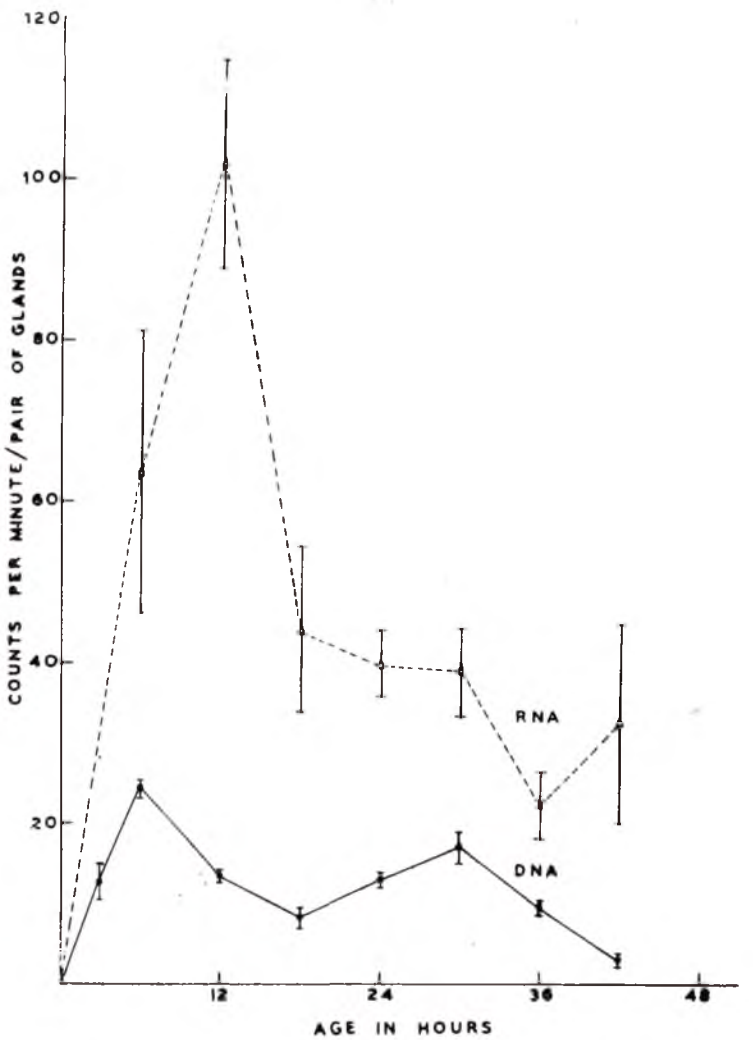


Fig. 1. Uptake of ^{3}H–thymidine and ^{3}H–uridine respectively by the male accessory glands of *Ae. aegypti* (Bars represent mean ± SE)

washed protein was then dissolved in 50 μl of 1N NaOH and transferred to a scintillation vial containing 10 ml of Bray's mixture (BRAY, 1960) Radioactivity was estimated as described earlier. Counts of radioactivity are taken to indicate incorporation of ^{3}H–lysine into proteins alone though it is likely to include its incorporation into peptides and those associated with transfer RNA which would also have been precipitated with the cold TCA. Experiments were replicated 4 times with each age group. Total proteins of the accessory glands of the different age groups were determined by the method of LOWRY et al. (1951). Lysine incorporation is expresed as cpm per μg protein. In the present study DNA, and protein synthesis were measured in different mosquitoes as all the precursors could not be injected to the same mosquito without inflicting very high mortality.

A few accessory glands of 1 day old and 2 day old mosquitoes injected with ^{3}H–lysine were fixed, embedded in paraffin wax, sectioned and processed for autoradiography. The sections were coated with Kodak NTB–3 emulsion and exposed for 3 weeks in dark. The slides were later developed in Kodak developer and fixed in acid fixer. The radioactive grains were examined under a microscope. For control, similar sections were treated with protease before developing the slides.

RESULTS

The results for thymidine uptake, indicating DNA synthesis are giveen in Fig. 1. Thymidine incorporation reached a peak at 6 hr, declined about 60% by 18 hr, and then increased to a second peak at 30 hr. The peak at 30 hr was less than that of 6 hr, and a further decline in DNA synthesis was recorded from 30 to 42 hr.

Uridine uptake in the accessory glands indicating RNA synthesis, showed a 65–fold increase by 6 hr and a 100–fold maximal increase by 12 hr (Fig. 1). Thereafter, the rate of incorporation of uridine drastically declined by 50% from 12 to 24 hr and almost continued at this level till 30 hr.

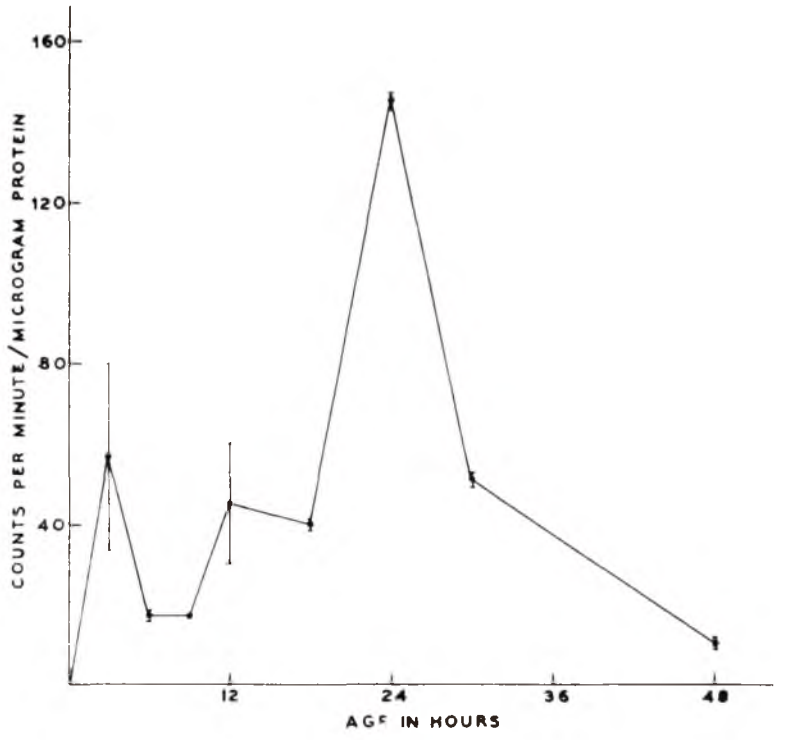


Fig. 2. Uptake of ^{3}H–lysine by the male accessory glands of *Ae. aegypti*.

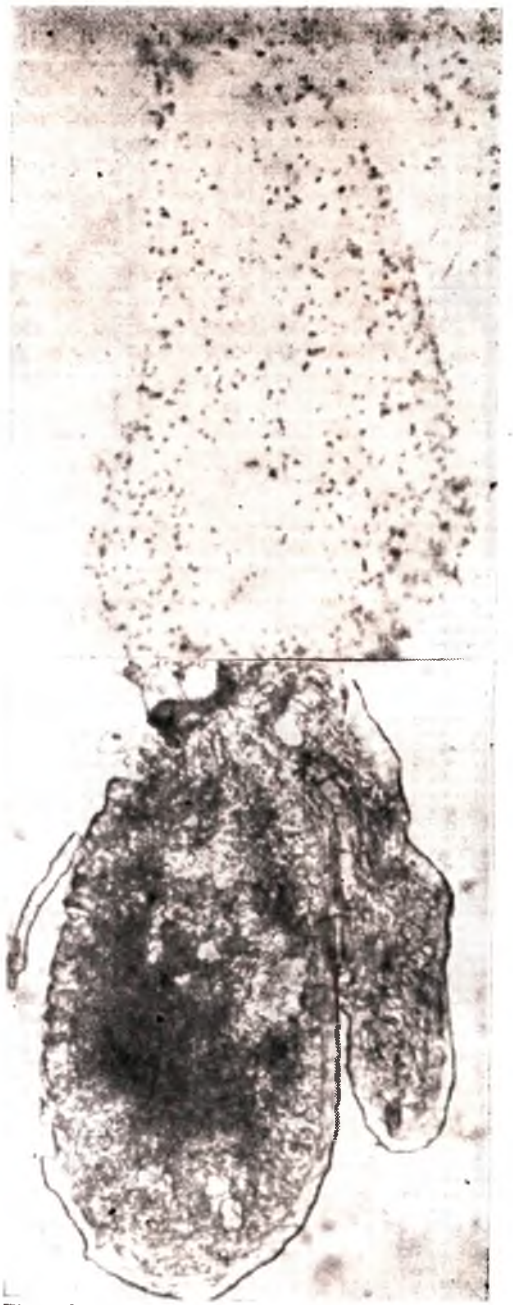
It again showed a drop in incorporation at 36 hr.

Results of the incorporation of ^{3}H-lysine into proteins of the accessory glands are given in Fig. 2. Maximum protein synthesis was found to be at 24 hr though a minor peak was indicated at 3 hr. From 0 to 24 hr there was a 145-fold increase in the incoproration of lysine but from 24 to 48 hr incorporation sharply declined.

Autoradiographs of 1 day old accessory glands showed dense incorporation of lysine in the central region of the gland (Fig. 3). However, in the 2 day old glands radioactive grains were comparatively few (Fig. 4).

DISCUSSION

The males of *Ae. aegypti* attain sexual maturity 2 days after adult emergence and by this time the accessory glands are completely filled with secretions (DAPPLES *et al.*, 1974; ADLAKHA *et al.*, 1976). It is evident from the present data that the syntheses of nucleic acids and proteins are almost completed by that time, suggesting that the synthetic activity is related to the mosquito attaining sexual maturity. Though DNA synthesis showed 2 peaks, maximum synthesis occurred at 6 hr and was followed by a rise in RNA synthesis at 12 hr. This increase in RNA, subsequent to that of DNA would indicate protein synthesis in the glands. It is indeed so, as evidenced by the incorporation of lysine. Peak protein synthesis was observed at 24 hr and was further confirmed by the autoradiographic studies which showed a high rate of incorporation of lysine into the gland secretion. It is evident from the data that protein synthesis probably continued till 30 hr. However, this continued protein synthesis was not preceded by a further increase in RNA. This indicates the



Figs. 3–4. Autoradiographs of the accessory glands of 1 day old (Fig. 3, below) and 2 day old (Fig. 4, above) adults of *Ae. aegypti* showing incorporation of ^{3}H-lysine × 400).

possibility of a stable m RNA triggering the continued biosynthesis of proteins. Similar evidence of stable mRNA has been suggested in the biosynthesis of proteins in the accessory glands of *Musca* (LEOPOLD *et al.*, 1971) and *Acheta* (KAULENAS *et al.*, 1975). By 48 hr protein synthesis is almost completed in the glands and this is further confirmed by the autoradiographs. The proteins of *Ae. aegypti* appear to be basic in nature, having high lysine content similar to that found in *Musca* (LEOPOLD *et al.*, 1971). It may be concluded from the present studies that the syntheses of DNA, RNA and protein in the accessory glands follow in an orderly sequence and the completion of the protein synthesis is synchronized with the male mosquito attaining sexual maturity.

REFERENCES

ADLAKHA, V. & M.K.K. PILLAI (1975) Involvement of male accessory gland substance in the fertility of mosquitoes. *J. Insect Physiol.*, **21:** 1453–1455.

ADLAKHA, V. & M.K.K. PILLAI (1976) Role of male accessory gland substance in the regulation of blood intake by mosquitoes. *J. Insect Physiol.*, **22:** 1441–1442.

ADLAKHA, V., S. BHARGAVA, & M.K.K. PILLAI (1976) Histological and histochemical studies on the male accessory glands of culicine mosquitoes. *Entomon*, **1:** 101–110.

BRAY, G.A. (1960) A simple efficient liquid scintillator for counting aqueous solutions in a liquid scintillation counter. *Analyt. Biochem.*, **1:** 279–285.

CRAIG, G.B., JR. (1967) Mosquitoes female monogamy induced by male accessory gland substance. *Science*, **156:** 1499–1501.

DAPPLES, C.C., W.A. FOSTER & A.O. LEA (1974) Ultrastructure of the accessory gland of the male mosquito, *Aedes aegypti* (L.) (Diptera: Culicidae). *Int. J. Insect Morphol. & Embryol.*, **3:** 279–291.

DOWNE, A.E.R. (1975) Internal regulation of rate of digestion of blood meals in the mosquito, *Aedes aegypti*. *J. Insect Physiol.*, **21:** 1835–1839.

FUCHS, M.S., G.B. CRAIG & D.D. DESPOMMIER (1969) The protein nature of the substance inducing female monogamy in *Aedes aegypti*. *J. Insect Physiol.*, **15:** 701–709.

FUCHS, M.S. & E.A. HISS (1970) The partial purification of the protein components of matrone from *Aedes aegypti*. *J. Insect Physiol.*, **16:** 931–939.

KAULENAS, M.S., R.L. YENOFSKY & H.E. POTSWALD (1975))Protein synthesis by the accessory gland of male house cricket, *Acheta domesticus*. *J. exp. Zool.*, **193:** 21–36.

LEAHY, M.G. & G.B. CRAIG (1965) Male accessory gland substance as a stimulant for oviposition in *Aedes aegypti* and *A. albopictus*. *Mosquito News*, **25:** 448–452.

LEOPOLD, R.A., A.C. TERRANOVA, B.J. THORSON & M.E. DEGRUGILLIER (1971) The biosynthesis of the male housefly accessory secretion and its fate in the mated female. *J. Insect Physiol.*, **17:** 987–1003.

LOWRY, O.H., N.J. ROSEBROUGH, A.L. FARR & R.J. RANDALL (1951) Protein measurement with the Folin phenol reagent. *J. Biol. Chem.*, **193** : 265–275.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 31 *to* 33

PRELIMINARY STUDIES ON THE DAMAGE CAUSED BY BRINJAL LEAF BEETLE, *HENOSEPILACHNA VIGINTIOCTO-PUNCTATA* (FABR.) ON BRINJAL *SOLANUM MELONGENA* LINN.

SHANTHA PREMA RAJ & M. LAKSHMANAN
Department of Microbiology, School of Biological Sciences,
Madurai Kamaraj University, Madurai, India 625 021

(*Received 14 August 1979*)

The brinjal leaf beetle *Henosepilachna vigintioctopunctata* (FABR.) attack was more during January (1979) planted brinjal than on the crop planted in December (1978). January planted crop was attacked in the early growth phase resulting in stunted growth and yield reduction. A maximum population of 226 adults and 99 grubs/100 leaves was recorded during peak infestation. The amount of leaf area damaged was directly proportional to the size of the insect population.

(*Key words* : **damage, brinjal leaf beetle)**

INTRODUCTION

The leaf beetle, *Henosepilachna vigintioctopunctata* (FABR.) (Coccinellidae : Coleopetera) is a major foliar pest of brinjal, *Solanum melongena* L. RAI & GOPAL (1975) have reported that it also attacks tender fruits of brinjal. The grubs and adults scrap the tender foliage, and skeletonise it to a papery structure. Severe damage results in the death of young plants and reduction in yield of the grown up plants (SAMBANDEM *et al.*, 1972). In the pre sent study, an attempt was made to estimate the population of the beetle on brinjal in two different months and the extent of damage caused to the crop.

MATERIAL AND METHODS

The brinjal (Var: *Pusa purple long*) seedlings were planted in December (1978) and January (1979). In each plantation four plots ($3m^2$) were marked; in each plot 15 plants were selected and grubs and adults present in the second and third leaves from top were counted once in two days from 27.3.79 to 24.4.79. To determine the leaf area damaged, second leaf from the top was removed from 5 randomly selected plants from each plot on the 10th of each month during February, March and April. The total area of the leaf as well as that damaged by the insect were measured using a planimeter. The yield from both was also recorded at periodic intervals.

RESULTS AND DISCUSSION

Data on population census of grubs and adults recorded in the field are given in Table 1. Adult population of *H. vigintioctopunctata* recorded as early as February in the January crop; in the December crop it was recorded only in late March. This indicates that the late crop is more susceptible for infestation by the pest than the earlier crop. The population had already consumed a major proportion of its total consumption on Janurary planted brinjal. In the December crop, a maximum of 84 adults and 15 grubs/100 leaves was noticed on 12.4.79 and the growth of the population was slow. In the case of January crop, the growth of the pest was quick and a maximum of 226 adults and 99 grubs/100 leaves was recorded as early as 29.3.79. Thereafter, the population started decreasing steadily and reached the minimum of 1.0 adult/100

leaves on 20.4.79. The grub population disappeared in early April from the late planted crop and in late April from the early planted crop, suggesting the cessation of multiplication of the pest. The pest was reported to be active on brinjal in North India between February and November (THAKUR, 1966) and on potato in Mysore during January to February and August to October (KRISHNAMURTHI & APPANNA, 1951). It is interesting to note that the population of grubs was very small in December planted crop in all the periods compared to that in January planted crop. So the leaf damage inflicted by adult beetles which migrated from the adjacent plots of January plantation was less and the pest as such multiplied very little on December plantation. The yield was only 4.0 kg/45 m^2 in late planted crop compared to 102.3 kg/45 m^2 of the early planted crop. This is becasuse, the January crop was attacked by the leaf beetle in the very early stage itself resulting in the stunted growth of the plant. So the tender leaves of the January planted crop were favoured much by the brinjal leaf beetle for its consumption. It multiplied fast on young plants than on older ones.

The amount of leaf areas damaged was more in the crop planted during January (Table 2). It was measured by taking only

TABLE 1. Number of adults and grubs of the brinjal leaf beetle.

Date of observation	January planted crop		December planted crop	
	Grub	Adult	Grub	Adult
27.03.79	92 ± 3.00	214 ± 8.00	0 ± 0	4 ± 0.82
29.03.79	99 ± 11.0	226 ± 6.26	0 ± 0	3 ± 0.82
31.03.79	78 ± 3.48	223 ± 3.06	1 ± 0.43	12 ± 0.82
2.04.79	85 ± 4.53	213 ± 6.34	0 ± 0	23 ± 2.11
4.04.79	73 ± 7.03	173 ± 5.84	3 ± 0.82	23 ± 2.93
6.04.79	116 ± 1.47	150 ± 4.82	3 ± 1.29	43 ± 3.67
8.04.79	33 ± 3.14	139 ± 3.01	2 ± 0.50	70 ± 2.35
10.04.79	0 ± 0	54 ± 3.80	0 ± 0	66 ± 2.26
12.04.79	0 ± 0	37 ± 1.57	15 ± 2.05	84 ± 3.81
14.04.79	0 ± 0	9 ± 1.47	13 ± 2.33	73 ± 2.22
16.04.79	0 ± 0	2 ± 0.50	12 ± 1.11	52 ± 8.45
18.04.79	0 ± 0	0 ± 0	0 ± 0	53 ± 6.09
20.04.79	0 ± 0	1 ± 0.43	0 ± 0	28 ± 1.11
22.04.79	0 ± 0	0 ± 0	0 ± 0	12 ± 1.11
24.04.79	0 ± 0	0 ± 0	0 ± 0	13 ± 1.57

Each value represents the mean ($\bar{x} \pm SE$) number of insects/100 leaves counted to four plots of 3m^2 area each.

the second leaves from the field. As much as 33.31 cm^2 of the total area of second leaf was damaged in the January planted crop as against 21.12 cm^2 in the December crop. In February the damage was seen only in January plantation. In March though the damage was more in January planted crop, no significant difference could be observed between the two plantations. In April, the damage was significantly more on early planted crop. While there was a progressive increase of damage in the December crop, there was a severe initial damage in the January crop which gradually decreased.

TABLE 2. Field observations on leaf consumption (cm^2) by the brinjal beetle, *H. vigintioctopunctata* (on brinjal plantations planted in two different months).

Month of observation	Leaf area consumed (cm^2)		
	December plantation	January plantation	Mean
February	0.57	45.21	22.89
March	29.09	35.68	32.39
April	33.69	19.06	26.38
Mean	21.12	33.31	

	CD (P = 0.05)
Between plantings	3.81 **
Between periods/months	4.66 **
Interaction between planting & periods	7.62 **

Arc sign transformed values
** Significant at 1% level.

This can be well explained based on the population recorded in the respective plantations, there is a positive relatonship between the size of the insect population (Table 1) and the leaf area damaged (Table 2).

The beetle infestation was getting increased with delayed sowing. However, if we make a check in the next season by advancing the date of transplantation to late November or early December, the pest attack can be minimized in and around Madurai (Tamil Nadu).

REFERENCES

KAREEM, A.A., S. SADAKATHULLA & T.R. SUBRAMANYAM (1973) Studies on an antifeedant to prevent the leaf damage of egg plant by *Epilachna* grubs. *South Indian Hort.*, **23** (3): 100–103.

KRISHNAMURTHI, B. & B. APPANNA (1951) Occurrence, distribution and control of major insect pest of some important crops in Mysore. *Mysore agric. J.*, **23**: 1–23.

RAI, P.S. & D.R. GOPAL (1975) Feeding activity of *Epilachna vigintioctopunctata* FABRICIUS on brinjal (*Solanum melongena* L.) fruits. *Indian J. Ent.*, **37** (1): 84.

SAMBANDAM, C.N., V. SIVASUBRAMANIAN, S. CHELLAIAH & K. NATARAJAN (1972) Scheme for the evaluation of eggplant varieties for resistance to the spotted beetle (*Epilachna vigintioctopunctata* F.) the aphid (*Aphis gossypii* G.) and little leaf virus. Final report. USDA P.L. 480, Annamalai University. 42 pp.

THAKUR, M.R. (1966) Common insect pest of temperate vegetable crops with special reference to Uppon Kulu Valley. *Punjab. Hort. J.*, **6**(3–4): 128–192.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 35 *to* 37

CHEMICAL CONTROL OF *CHILO PARTELLUS* (SWINHOE) IN FODDER SORGHUM

B. M. GUPTA, V. K. R. SHINDE & S. K. SHARMA
Agricultural Research Station, Durgapura, Jaipur, India 302 004

(Received 30 June 1979)

Carbofuran, dimethoate, mephosfolan and quinalphos in granular formulation and carbaryl in wettable powder and endosulfan, phenthoate, phosalone and quinalphos in emulsifiable concentrate were tried against the sorghum stem borer, *Chilo partellus* (SWINHOE) in fodder sorghum. Side dressing of either mephosfolan 5G or carbofuran 3G (1.00 Kg a i ha), or spraying 1.425 l ha of endosulfan 35 E C effectively controlled the fodder sorghum crop from stem borer infestation.

(*Key words:* **chemical control, *Chilo partellus***)

INTRODUCTION

The sorghum stem borer, *Chilo partellus* (SWINHOE) is a major pest of sorghum and is most active from July to December (PANT & KALODE, 1963). In Rajasthan, so far this pest was observed to cause heavy losses in monsoon sown sorghum crop and the summer crop which is raised for fodder purposes, practically escaped the attack of this pest. With the introduction of Diary Development Programme in Alwar district (Rajasthan), raising of summer crop has been encouraged and consequently the area under summer crop has increased many folds in the district during the recent years. This change in the cropping pattern and fodder cultivation under irrigated conditions has favoured the breeding of *C. partellus* during summer season and the survey conducted in the area for estimation of losses revealed 70 to 80 per cent infestation in this crop during summer season.

Various chemical control recommendations are on record (VITTAL RAO *et al.* 1966; ATWAL *et al*, 1970; SANDHU & BRAR 1971; CHATTERJI *et al*, 1972; JOIA & DESHMUKH, 1973; SINHA & VERMA, 1978) for the effective control of this pest. Since most of the studies have been conducted on monsoon raised crop, it was thought pertinent to evaluate some insecticides as sprays and granules in summer crop, as the great environmental variations betweeen summer and monsoon season are expected to affect the performance of the insecticides. Further, as the crop is raised for fodder purpose, it necessitates the minimum use of safer insecticides preferably at lowest possible dose. With this view, the present studies were conducted and the findings are reported herein.

MATERIALS AND METHODS

The present experiment was conducted on a farmers' field at Alwar in a randomized block design with plot size of 5m × 4m. There were three replications. The sorghum variety, *N.P. Charrie* was sown on 1.4.78 and other cultural practices as recommended for the region were followed. The insecticides tested were four granular formulations viz., carbofuran 3G, dimethoate 5G, mesphosfolan 5G and quinalphos 5G (all at the rate of 1.00 Kg a i ha) and five spray formulations viz., carbaryl (50WP), endosulfan (35EC), phenthoate (50EC) phosalone (34EC) and quinalphos (25EC) at the rate of 2.50 Kg, 1.425, 0.500, 0.590 and 1.00 litre ha of formulated product respectively and diluted in 500 litres of water. The treatments were given to 15 days old crop. The granules were

TABLE 1. Effect of different insecticides on the damage to *Chilo partellus* (SWINHOE) in fodder sorghum.

Treatment	Dose*	Average per cent increase in damage after treatment								
		15 days			22 days			30 days		
		Infestation (pin hole injury)	Dead hearts	Infestation including dead hearts	Infestation (pin hole injury)	Dead hearts	Infestation including dad hearts	Infestation (pin hole injury)	Dead hearts	Infestation including dead hearts
1	2	3	4	5	6	7	8	9	10	11
Carbofuran 3G	1.00	1.80 (7.70)	0.40 (3.54)	2.20 (8.52)	4.36 (12.02)	2.00 (8.10)	6.36 (14.57)	5.16 (13.09)	2.44 (8.92)	7.60 (15.94)
Dimethoate 5G	1.00	18.76 (25.15)	3.00 (9.96)	21.76 (25.66)	20.70 (25.37)	4.40 (11.53)	22.36 (28.21)	20.03 (26.58)	4.60 (12.37)	24.63 (29.75)
Mephosfolan 5G	1.00	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.50 (6.96)	0.36 (3.41)	1.86 (7.81)	2.13 (8.37)	0.67 (4.67)	2.80 (9.61)
Quinalphos 5G	1.00	16.43 (23.82)	2.00 (8.12)	18.43 (25.66)	18.36 (25.37)	4.00 (11.53)	22.36 (28.21)	20.03 (26.58)	4.60 (12.37)	24.63 (29.75)
Carbaryl 50WP	2.50	15.86 (23.46)	1.80 (7.70)	17.66 (24.85)	17.26 (24.54)	3.56 (10.88)	20.82 (27.15)	18.46 (25.44)	4.20 (11.81)	22.66 (28.42)
Endosulfan 35EC	1.425	3.03 (10.01)	1.10 (5.96)	4.13 (11.70)	5.53 (13.57)	2.90 (9.73)	8.43 (16.87)	8.50 (16.93)	3.80 (11.19)	12.30 (20.50)
Phenthoate 50 EC	0.500	30.16 (33.30)	7.70 (16.09)	37.86 (37.97)	31.73 (34.28)	8.60 (17.04)	40.33 (39.42)	34.16 (35.76)	9.26 (17.70)	43.42 (41.22)
Phosalone 34 EC	0.590	26.96 (31.28)	6.37 (14.58)	33.33 (35.25)	28.00 (31.94)	7.30 (15.64)	35.30 (36.44)	30.04 (33.23)	7.86 (16.25)	37.9 (37.99)
Quinalphos 25 EC	1.000	24.33 (29.55)	3.97 (11.46)	28.30 (32.14)	25.43 (30.28)	5.40 (13.42)	30.83 (33.72)	26.70 (31.11)	6.20 (14.39)	32.90 (34.99)
Control	—	34.13 (35.73)	11.07 (19.42)	45.20 (42.24)	37.60 (37.81)	12.20 (20.44)	49.80 (44.88)	48.80 (44.31)	14.53 (22.40)	63.33 (52.77)
C D at 5%		1.84	1.13	1.86	1.91	1.38	1.84	1.99	1.34	2.12

*For granular formulation = Kg ai/ha
For emulsion concentrate = Litre of formulated product/ha
Figures in paranthesis represent angular values.

applied in the soil near plants by side dressing followed by irrigation. Observations on number of infested plants and dead hearts were recorded only one day before treatment and 15, 22 and 30 days after treatment. The per cent increase in the number of infested plants and dead hearts were computed and subjected to statistical anlysis after angular transformation of values.

RESULTS AND DISCUSSION

The average per cent increase infestation based on the characteristic pin hole injury and dead hearts recorded after 15, 22 and 30 days after treatment (Table 1) reveal that all the insecticidal treatments significantly reduced the infestation as compared to control.

The average per cent infestation (pin hole injury) was least in plots treated with mephosfolan and carbofuran granules as compared to other treatments. Amongst the sprays, endosulfan spray was most effective. All the treamen.s were also superior than control to reduce the infestation of dead hearts. Thus, application of mephosfolan and carbofuran granules resulted in the least pin hole injury and dead heart formation in sorghum plants. Mephosfolan and carbofuran granules have also been reported to be effective against stem borer in maize by CHATTERJI *et al.* (1972). SANDHU & BRAR (1971) reported mephosfolan 1.5 to 2.0 Kg ai/ha and aldicarb 3.0 to 4.0 Kg ai/ha as top dressing to the standing crop to be effective against stem borer. Endosulfan spray was found to be the best next treatment with 12.30 per cent total incidence after 30 days of treament. JOIA & DESHMUKH (1973) found that spray and granular formulations of both trichlorphon and endosulfan proved to be the most effective against *C. partellus* infesting maize. Carbaryl with 22.66 per cent incidence was superior to the rest of the insecticides. There was no significant difference among dimethoate and quinalphos granules and both the treatments were at par. On the basis of overall performance, side dressing of mephosfolan (5G) was found to protect the crop from stem borer infestation. The descending order of efficacy of the remaining treatments was found to be carbofuran (5G), endosulfan (EC), carbaryl (WP), quinalphos (G), dimethoate (G), quinalphos (EC), phosalone (EC) and phenthoate (EC).

Acknowledgements:— The authors express their sincere thanks to Dr. R.L. MATHUR, Joint Director (Research), Agricultural Research Station, Durgapura, Jaipur for providing necessary facilities. Grateful thanks are also due to Dr. G.N. BHATT Project Officer, Dairy Development Corporation, Alwar in selection of site and for making arrangements in conducting the trial.

REFERENCES

ATWAL, A.S., B.S. CHAHAL & M. RAMZAN (1970) Insecticidal control of maize stem borer, *Chilo partellus* (SWINHOE) (Crambidae: Lepidoptera). *Indian J. agric. Sci.*, **40**(2): 110–116.

CHATTERJI, S.M., P. SARUP, M.W. BHAMBURKAR, K. K. MARWAHA, V. P. S. PANWAR & K. H. SIDDIQUI (1972) Evolution of control schedule for the pests of maize with particular reference to the stem borer, *Chilo zonellus* SWINHOE. *Indian J. Ent.*, **34**(2): 142–147.

JOIA, B.S. & S.N. DESHMUKH (1973) Comparative evaluation of some insecticides for the control of stalk borer, *Chilo partellus* (SWINHOE) infesting maize. *Indian J. Ent.*, **35**(2): 127–129.

PANT, N.C. & M.B. KALODE (1963) Pests of wheat, maize and millets, *Entomology in India*, 279–292.

SANDHU, G. & H.S. BRAR (1971) Spot insecticides treatment for the control of maize borer, *Chilo partellus* (SWINHOE) (= *zonellus* S.) and possible solution of other pests problems. Paper presented at the 7th Inter-Asian Corn Improvement Workshop held at U.P. College of Agriculture, Philippines, 112–116 pp.

SINHA, P.K. & G.D. VERMA (1978) Evaluation of some granular insecticides for the control of maize stem borer, *Chilo partellus* (SWINHOE). *Indian J. Ent.*, **40**(4): 434–435.

VITTAL RAO, S., B.A. KHAN & M. ANAVARTHAM (1966) Insecticidal trial for the control of maize stem borers. *Indian J. agric. Sci.*, **36**(1): 35–39

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 39 *to* 42

PARASITES AND PREDATORS OF APHIDS IN SIKKIM AND MANIPUR (NORTHEAST INDIA). III.

BASANT K. AGARWALA, D. RAYCHAUDHURI & D. N. RAYCHAUDHURI
Entomology Laboratory, Department of Zoology, Calcutta University,
Calcutta, India 700 019

(*Received 14 August 1979*)

This paper reports 8 species of aphidiid parasites and 5 species of coccinellid predators of aphids from Sikkim and Manipur respectively. Among the parasites 2 species are new record from India and 4 species are new record from the state of Sikkim. Besides for 3 parasitic species 3 new aphid hosts have been recognised in the area of study. All predatory species are new records for the state of Manipur.

(*Key words:* **parasites and predators of aphids)**

This is the third paper in the series. In this paper 8 species of aphidiid parasites from Sikkim and 5 species of coccinellid predators from Manipur are reported. Among these new records for India have been denoted by one (*) mark, new records from the area of collection by two (**) marks and new aphid host species by three (***) marks. Each species of parasites and predators has been provided with necessary collection data. Materials of the reported parasites and predators are in the collections of Entomology Laboratory, Department of Zoology, University of Calcutta.

APHIDIID PARASITES

1. *Aphidius absinthii Marshall

Aphidius absinthii Marshall, 1896, Spec. Hym. Eur. 5 : 605.

Host : *Macrosiphoniella yomogifoliae* (Shinji) from *Artemisia* sp., 11. xii. 1977, Gaylzing (*c* 1768 m), Sikkim.

This species is known to be parasitic on aphid species of *Macrosiphoniella* or *Dactynotus* in different parts of Europe and Japan (Takada, 1968).

2. **Aphidius cf. **matricariae** Haliday

Aphidius (*Aphidius*) *matricariae* Haliday, 1834. Ent. Mag., 2 : 103.

Hosts : *Brachycaudus helichrysi* (Kalt.) from *Ageratum conyzoides*, 10.xii. 1977, Namchi (*c* 1666 m), Sikkim ; 23. ii. 1978, Gangtok (*c* 1675 m), Sikkim; *Aphis gossypii* complex from *Hibiscus esculentus*, 7.xii.1977, Gangtok (*c* 1675 m), Sikkim; *Myzus persicae* (Sulzer) from *Brassica napus*, 14.xii.1977, Melli (*c* 235 m), Sikkim; *Aphis spiraecola* Patch from *Bidens pilosa*, 23.ii. 1978 and *Gynura angutosa*, 24.ii. 1978, Gangtok (*c* 1675 m), Sikkim.

Stary (1973) reported this species as parasite of a number of aphids belonging mostly to either aphidine or myzine group. In Sikkim also this parasite shows similar host preference.

3. *Aphidius similis Stary and Carver (Ms. name)

Hosts : *Aphis gossypii* complex from *Hibiscus esculentus*, 7.xii. 1977, Gangtok (*c* 1675 m), Sikkim; *Aphis spiraecola* Patch

from *Bidens pilosa*, 23.ii.1978, Gangtok (*c* 1675 m), Sikkim; *Brachycaudus helichrysi* 1977, (Kalt.) from *Ageratum conyzoides*, 10.xii. 1977; Namchi (*c* 1666 m), Sikkim: *Myzus persicae* (Sulzer) from *Brassica napus*, 14.xii. 1977, Melli (*c* 235 m) Sikkim, *Solanum tuberosum*, 23.ii.1978, Gangtok (*c* 1675 m), Sikkim.

Interestingly this species has the same host and habitat preference as those of *A. matricariae*.. Their period of incidence also coincides. Stary and Carver (Ms. name) have described this species from Australia.

4. **Aphidius uzbekistanicus Luzhetzki

Aphidius beltrani Quilis, 1931, Eos Madrid, 7: 51–54.

Aphidius (*Aphidius*) *uzbekistanicus* Luzhetzki, 1960. Par tlejfuzbekistan, 1 : 22–23.

Host : *** *Rhopalosiphum maidis* (Fitch) from *Hordeum vulgare*, 22.ii. 1978, Ranipul, Sikkim.

Shuja Uddin (1975) reported from Uttar Pradesh for the first time this species as a parasite of *Macrosiphum* (*Sitobion*) species infesting *Triticum aestivum* L.

5. **Diaeretiella rapae (M' Intosh)

Aphidius rapae M' Intosh, 1855. Book of the Garden, 2 : 194. *Diaeretiella rapae* (M'Intosh) ; Stary, 1961, Acta Ent. Mus. Nat. Prague, 34 : 384.

Host : *Lipaphis erysimi* (Kalt) from *Brassica oleracea*, 10.xii. 1977, Namchi (*c* 1666 m), Sikkim.

This is one of the very common aphidiid insects found in the world as a parasite of a number of aphid species. Kundu *et. al.* (1965), Dharmadhikari and Ramaseshiah (1971) and Stary and Ghosh (1975, 1978) have reported this species parasitising many aphid species belonging to subfamily Aphidinae in various parts of India.

6. Ephedrus plagiator (Nees)

Bracon plagiator Nees, 1811, Mag. Ges. natuf. Preunde Berlin, 5 : 17. *Aphidius* (*Ephedrus*) *plagiator* Nees; Haliday, 1833, Ent. Mag., 1 : 486. *Ephedrus* (*Ephedrus*) *plagiator* (Nees); Stary, 1958, Acta faun. ent. Mus. Nat. Prague, 3 : 64; 76–79.

Hosts : *Acyrthosiphon pisum* Harris from *Pisum sativum*, 23.ii. 1978, Namchi (*c* 1666 m), Sikkim; *Myzus persicae* (Sulzer) from *Solanum tuberosum*, 26.ii. 1978, Gangtok (*c* 1675 m), Sikkim; *** *Macrosiphum* (*Sitobion*) *rosaeiformis* Das from *Rosa*, sp., 1.iii.1978, Gangtok (*c* 1675 m), Sikkim.

It is a cosmopolitan species. Raychaudhuri et al. (1978) reported it from Sikkim parasitic on *Myzus persicae* infesting *Brassica oleracea*.

7. Lipolexis scutellaris Mackauer

Lipolexis scutellaris Mackauer, 1962, Entomophaga, 7 : 43–44.

Host : *Aphis fabae* complex from *Vicia faba*, 12.xii. 1977, Gaylzing (*c* 1768 m) Sikkim.

Dharmadhikari and Ramaseshiah (1970), Stary and Ghosh (1975) and Rishi (1976) have reported this species as a parasite of a number of aphid species in different parts of India.

8. **Trioxys indicus Subba Rao and Sharma. *Trioxis* (*Trioxys*) *indicus* Subba Rao and Sharma, 1958. Ind. J. Ent., 20 : 199–201.

Hosts : ****Aulacorthum magnoliae* (Essig and Kuwana), *Aphis gossypii* complex *Myzus persicae* (Sulzer) from *Sechium edule*, 9.xii.1977, 10.xii. 1977 and 1.iii. 1978 respectively, Gangtok (*c* 1675 m) and Namchi (*c* 1666 m) Sikkim.

Dharmadhikari and Ramaseshiah (1970), Rishi (1976), Stary and Ghosh (1978) and Raychaudhuri et al. (1978) have recorded the incidence of this parasite on a number of aphidine species in India.

COCCINELLID PREDATORS

Order — Coleoptera

Family — Coccinellidae

1. **Coelophora sexareata Muls.

Host : *Brachycaudus helichrysi* (Kaltenbach) from *Clerodendron* sp., 13.v.1978, Ukhrul, (*c* 2000 m), Manipur; *** *Shinjia pteridifoliae* (Shinji) from fern, 12.v.1978, Lamblang (*c* 1600 m), Manipur,

Predatory stage – Adult.

This species has been reported by Raychaudhuri et al (1978, 1979) from Kalimpong, West Bengal predating on *Taoia indica, Macrosiphum rosae* and *Macrosiphum* (*Sitobion*) *rosaeiformis* and by Rao (1969) from the same area predating on some unidentified aphids infesting *Artemisia* sp. From the records so far available it appears that this beetle predates on aphids of the tribe Macrosiphini.

2. **Oenopia luteopustulata Muls.

Host : ****Brachycaudus helichrysi* Kaltenbach) from *Clerodendron* sp., 13.v. 1978, Ukhrul (*c* 2500 m), Manipur.

*** *Macrosiphoniella sanborni* (Gillette) from *Artemisia vulgaris,* 12.v.1978, Lamlang (*c* 1600 m), Manipur.

Predatory stage – Adult

Raychaudhuri et al (1978, 1979) found this species in Kalimpong predating on *Macrosiphum rosae* and *Macrosiphum* (*Sitobion*) *rosaeiformis.* Ghosh et. al. (in press) observed this species predating on *Lipaphis erysimi* in and around Calcutta. This species like the previous one shows preference for macrosiphine species.

3. **Oenopi fauzeti Muls.

Host : ****Coloradoa artemisicolea* Takahashi from *Artemisia vulgaris,* 12.v. 1978, Lamlang (*c* 1600 m), Manipur.

Predatory stage – Adult.

This species has been reported by Raychaudhuri et. al. (1978) feeding on *Macrosiphoniella pseudoartemisiae* in Kalimpong, West Bengal. It appears that this species prefers aphids infesting *Artemesia spp.*

4. **Scymnus sp.

Host : *Taoia indica* (Ghosh and Raychaudhuri) from *Alnus nepalensis,* 19.v. 1978, Mao (*c* 2400 m), Manipur.

Predatory stage – Adult.

Species of the genus has been reported by Rao (1969) to predate on *Aphis gossypii* in Kalimpong, West Bengal and Tamil Nadu. Johnson (1979) records *Scymnus nubilus* from Kerala as a predator of some unidentified aphids. This species of ths genus appears to feed on apids belonging widely divergent subfamilies like Aphidinae and Callipterinae

5. **Verania sp.

Host : *Eutrichosiphum taoi* Ghosh, Basu and Raychaudhuri from *Quercus serrata,* 13.v. 1978, Ukhruul (*c* 2000 m), Manipur Predatory stage – Adult.

Samalo and Mahendranath (1977) and Johnson (1979) recorded *Verania discolor* as predator of some unidentified aphids occuring in Orissa and Kerala respectively.

Acknowledgements:—Thanks are due to ICAR and UGC, New Delhi for partly financing the works, to Zoological Survey of India, Calcutta for identifying the aphid predators and to Dr. P. Stary of Czechoslovak Institute of Entomology, Prague for commenting on the aphid parasites.

REFERENCES

DHARMADHIKARI, P.R. & G. RAMASESHIAH (1970) Recent records of Aphidiids (Hym., Aphidiidae) in India. *Tech. Bull. Commonw Inst. biol. Control.*, **13:** 83–89.

JOHNSON, J. (1979) Note on some common aphidiuorous insects in Kerala. *Abs. Symp. Recent Trends in Aphidological Studies*, Utkal Univ., Bhubaneswar.

KUNDU, G. G., V. K. SHARMA, R. K. ANAND & SAMARJIT RAI (1965) New record of *Diaeretiella, rapae* (CURTIS) as a parasite of mustard aphid *Lipaphis erysimi* (KALT). (Hemiptera: Aphidae). *Indian. J. Ent.*, **27:** 497–498.

RAYCHAUDHURI, D.N., S. DUTTA, BASANT K. AGARWALA, D. RAYCHAUDHURI & S. K. RAHA (1978) Some parasites and predators of aphids from northeast India and Bhutan. *Entomon*, 3:91–94.

RAYCHAUDHURI, D.N., S. DUTTA, BASANT K. AGARWALA, S. K. RAHA & D. RAYCHAUDHURI (1979) Some parasites and predators of aphids in northeast India and Bhutan. II. *Entomon*, **4**(2) : 163–166.

RAO, V.P. (1969) Survey for natural enemies of aphids in India, *CIBC, U.S. PL* 480 *Project: Final Technical Report*, 1–93.

RISHI, N.D. (1976) Survey and studies of Aphidiid parasites of Aphids. *Abs. Symp. on Modern Trends in Zoological Research in India.*, The Zoological Society, Calcutta, 47–48.

SAMALO, A.P. & P. MAHENDRANATH (1977) Effect of various food substances on longevity and fecundity of some ladybird beetles. *Indian. J. Ent.*, **39**(2): 190–192.

SHUJA UDDIN (1975) Two new species of Aphidiidae (Hymenoptera) from India. *Rec. Zool. Surv. India*, **68:** 415–420.

STARY, P. (1973) A review of the *Aphidius*-species (Hymenoptera: Aphidiidae) of Europe. *Ann. Zool. Bot.*, **84:** 1–85.

STARY, P. & A. K. GHOSH (1978) Aphid parasites (Hymenoptera: Aphidiidae) from Meghalaya, India, *Oriental. Ins.*, **9**: 343–349.

STARY, P. & A.K. GHOSH (1978) Further records of aphid parasitoids (Hymenoptera: Aphidiidae) from Meghalaya, India. *Oriental Ins.*, **12**: 77–78.

TAKADA, H. (1968) Aphidiidiidae of Japan (Hymenoptera). *Insecta Matsum*, **30**(2): 67–124.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 43 *to* 46

TWO NEW SPECIES OF THE GENUS BATRACOMORPHUS (HOMOPTERA : CICADELLOIDEA : IASSIDAE)*

P. KAMESWARA RAO
Department of Entomology, A. P. Agricultural University,
Hyderabad, India, 500 030

&

USHA RAMAKRISHNAN
Division of Entomology, Indian Agricultural Research Institute,
New Delhi, India 110 012

(Received 24 March 1979)

Two new species, *Batracomorphus menoni* sp. nov. and *B. linnavuorii* sp. nov. are described and illustrated.

(*Key words:* **new *Batracomorphus* from India)**

Distant (1907) collected *Bythoscopus chlorophana* Melichar (*Pachyopsis chlorophana* Melichar, 1903) from Calcutta and Pusa and *Macropsis indicus* Lethierry from Mahi (India). While giving a brief redescription of the former species Distant (1907) expressed that *M. indicus* might belong to the genus *Bythoscopus*. Ishihara (1953, 1961) transferred *B. chlorophana* to the genus *Batracomorphus* Lewis (1834). Metcalf (1966) transferred Distant's species *Bythoscopus rubrofrontalis, B. pulverus* and *B. piceatus* and Melichar's species *B. chlorophana* to another genus *Iassus* Fabricius. Linnavuori and Quartau (1975) treated *M. indicus* and *P. chlorophana* as synonyms of *Batracomorphus indicus* (Leth.). As such the genus *Batracomorphus* is represented in India by *B. indicus* along with the present two new species which can be separated according to key given separately.

All the parts were drawn with a prism type camera lucida except wings which were drawn with a microprojector. The lines were drawn to 1.00 mm scale in case of wings and to 0.2 mm for the rest of the figures. The holotypes of the species are deposited in National Pusa Collections, Indian Agricultural Research Institute, New Delhi-110012 and the paratypes will be deposited in Zoological Survey of India, Calcutta.

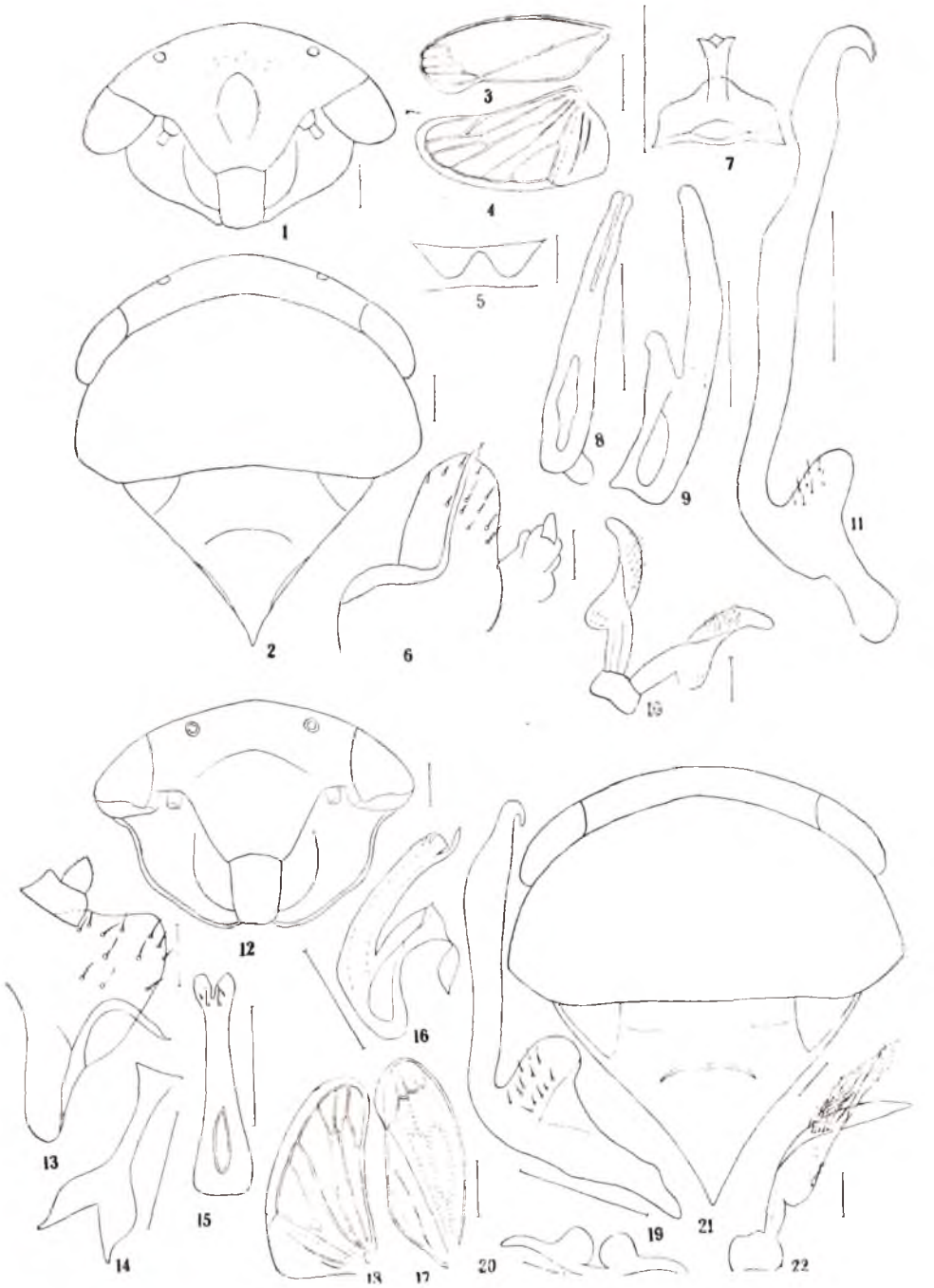
1. **Batracomorphus menoni** sp. nov. (Figs. 1–11)

Ochraceous brown with eyes testaceosu or black and blackish round ocelli situated near dorsal margin of face (Fig. 1). Postclypeus short and much broader than long. Anteclypeus more or less rectangular. Pronotum (Fig. 2) transversely striated with anterior margin convexly rounded and posterior margin slightly concave. Scutellum subtriangular with an arcuous transverse impression at middle of scutellum.

Forewing long (Fig. 3) and narrow with four apical and three anterapical cells. Hindwing (Fig. 4) with three apical cells.

---

* Adopted from the doctoral thesis submitted to the post-graduate school of Indian Agricultural Research Institute, New Delhi by the senior author.



Figs. 1–11. *Batracomorphus menoni* sp. nov. ♂: 1, Face; 2, Vertex, pronotum and scutellum; 3, Forewing; 4, Hindwing; 5, Abdominal apodemes; 6, Pygofer lobe with anal ring; 7, connective; 8, Aedeagus (dorsolateral view); 9, Aedeagus (lateral veiw); 10, Subgenital plates; 11, Paramere. Figs. 12–22. *Batracomorphus linnavuorii* sp. nov. ♂: 12, Face; 13, Pyogofer lobe with anal ring; 14, connective; 15, Aedeagus (dorsal view); 16, Aedeagus (lateral view); 17, Forewing; 18, Hindwing; 19, Paramere; 20, Abdominal apodemes; 21, Vertex, pronotum and scutellum; 22, Subgenital plate.

Male genitalia: Ninth sternum more or less rectangular. Subgenital plate (Fig. 10) long spatulate with apical third so folded that inner margin becomes outer and outer margin becomes inner at apical region; Pygofer (Fig. 6) broad at base and produced caudad into a narrowed and rounded lobe, a few macrosetae present on apical portion of this lobe and with long spine-like ventral pygofer process which is serrated at apex and extends beyond the pygofer lobe. Paramere (Fig. 11) long with cephalic portion short and ending in a flattened lobe-like portion, caudally it is thrice longer than cephalic portion with curved pointed apex. Connective (Fig. 7) cup-shaped with short, stout basal arm. Aedeagus (Figs. 8 and 9) with a short atrial apodeme; aedeagal shaft tubular, much longer than atrial apodeme, gonopore apical.

Abdominal apodemes (Fig. 5) broad at base and rounded at apex.

Measurements in millimeters (Length): Total—4.70; head—1.58; vertex—0.19; pronotum—0.86; forewing—3.65; scutellum—0.86.

Holotype: ♂ INDIA: Bihar: Pusa, 'light', 29.iv. 1935, Coll. H.S. Pruthi (wings and genitalia on slides and rest on tag).

Paratypes: 2♂♂, with the same data as for the holotype except dates, 5. iv. 1935 and 14. vii. 1935.

This species is very similar to *Batracomorphus richteri* Heller and Linnavuori (1968) but can be separated by the shape of the subgenital plates and pygofer processes, the caudal end of the former and the apex of the latter being pointed in *richteri* while the same rounded and serrated respectively in the present species.

The species is named in honour of Dr. Ramdas Menon, retired Senior Systematic Entomologist, Indian Agricultural Research Institute, New Delhi.

2. Batracomorphus linnavuorii sp. nov. (Figs. 12–22).

Ochraceous brown specimens with red ocelli and testaceous eyes.

Forewing (Fig. 17) and hindwing (Figs. 17 and 18) as in *B. menoni*.

Male genitalia: Ninth sternum and subgenital plate (Fig. 22) similar to that of *menoni* but hair present on folded portion of subgenital plate very long. Pygofer broad with macrosetae present on the posterior portion of the lobe. Pygofer process angularly pointed. Paramere (Fig. 19) long with cephalic portion triangular and pointed while caudal portion one and a half times that of the cephalic portion. Connective (Fig. 14) Y-shaped. Aedeagus (Figs. 15–16) with a short atrial apodeme; apex bifid and provided with short spines; gonopore apical.

Abdominal apodemes (Fig. 20) short and lobe-like.

Measurements in millimeters (length): Total 5.23; head—1.68: vertex—0.19; pronotum—1.06; forewing—3.98; scutellum—0.91.

Holotype ♂ INDIA: Tamil Nadu; Rameswaram 'light', 2. iv. 1975, coll. P.K. Rao (wings and genitalia on slides and rest on tag). **Paratypes:** 3♂♂ with the same data.

The species is named in honour of Dr. Rauno Linnavuori, 21220 Somersoja, Raisio, Finnland.

This species is similar to *B. menoni* sp. nov. but can be differentiated as shown in the key.

KEY TO THE INDIAN SPECIES OF *BATRACOMORPHUS* LEWIS

1. Aedeagus much curved; caudal apex of paramere short and beak-like ..... *B. indicus,*

— Aedeagus somewhat straight; caudal apex of paramere hook-like 2

2. Connective (Fig. 7) cup shaped; aedeagus (Fig. 9) with the caudal portion thrice the length of the cephalic portion..... *B. menoni* sp. nov.

— Connective (Fig. 14) Y-shaped; aedeagus (Figs. 15 & 16) with spines at the apex; paramere (Fig. 19) with the caudal portion one and a half times the cephalic portion..... *B. linnavuorii* sp. nov.

Acknowledgements:—The authors are thankful to Dr. N.C. Pant, formerly Head of the Division of Entomology, I.A.R.I., New Delhi-12 for the facilities provided.

REFERENCES

DISTANT, W.L. (1907) *The Fauna of British India including Ceylon and Burma. Rhynchota.* Ed. by C.T. BINGHAM **4:** 191.

HELLAR, V.F. & R. LINNAVOURI (1968) Cicadellidenus Athiopien. *Stuttgart. Beitr. Naturk.*, 186–225.

ISHIHARA, T. (1953) A tentative check list of the superfamily Cicadelloidea of Japan (Homoptera). *Scient. Rep. Matsuyama agric. Coll.*, **11:** 1–72.

ISHIHARA, T. (1961) Homoptera of South East Asia Collected by the Osaka city University Biological Expendition to South East Asia, 1957–1958, *in*: *Nature and life in Southern Asia*, **1**:234.

LEWIS, R.H. (1834) Description of some new genera of British Homoptera. *Trans R. ent. Soc. Lond.*, **1:** 47–52.

LINNAVUORI, R. & QUARTAU (1975) Revision of the Ethiopian Cicadellidae (Hemiptera—Homoptera): Iassinae and Acroponinae, Fondation pour favoriser les Recherches Scientifiques en Afrique *Etudes du continent Africain Fasc.* 3, Bruxelles 1: 144.

MELICHAR, L. (1903) *Homopteran—Fauna von Ceylon:* 148.

METCALF, Z.P. (1966) General catalogue of the Homoptera, Fasc. vi, pt. 13, *Agric. Res. Ser. U. S. Dept. Agric.* Washington D.C.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 47 *to* 48

BRIEF COMMUNICATION

PRECOCIOUS TANNING OF EGGS IN THE OVARIES OF THE YELLOW FEVER MOSQUITO, *AEDES AEGYPTI* (L.)

VIMLA ADLAKHA & M. K. K. PILLAI
Department of Zoology, University of Delhi, Delhi, India 110 007

(*Received 10 November 1979*)

A small percentage of female mosquitoes of *Aedes aegypti* mated with males devoid of accessory glands showed an unusual instance of premature tanning of eggs in their ovaries. The results seem to indicate a probable direct or indirect role of male accessory gland substance in the tanning of eggs.

(*Key words:* **precocious tanning, ovaries, yellowfever mosquito, *Aedes aegypti***)

Male accessory gland substance is known to trigger several physiological functions in adult female mosquitoes. Recent studies have demonstrated that it ensures fertility of sperms in *Aedes aegypti* (ADLAKHA & PILLAI, 1975). It is well known that in *Aedes* the eggs are white in colour at the time of oviposition and tanning of eggs takes place within 4 hrs (CHRISTOPHERS, 1960). The present paper deals with an unusual instance of premature tanning of eggs in the ovaries of mosquitoes which were mated with males without accessory glands.

A Delhi strain of *Ae. aegypti* (ADLAKHA & PILLAI, 1975) was used for the present study. Newly emerged female mosquitoes were isolated into two groups. One group was caged with males whose accessory glands were surgically removed (ADLAKHA & PILLAI, 1975) and the other group was mated with normal males. The females were provided with blood meal on the third day using a guinea pig (ADLAKHA & PILLAI, 1975). One day after the blood meal, females were collected at random from each cage and were dissected to examine their ovaries. The experiments were replicated four times using more than 100 females each time in each cross.

A few ovaries of the females mated with males without accessory glands contained tanned eggs (Fig. 1) unlike in the controls where the eggs were white in colour. Such ovaries with tanned eggs were found in about 8% of the females. Precocious tanning of eggs in the ovaries of *Ae. aegypti* indicates a probable function of the male

Fig. 1. Ovary of *Ae. aegypti* showing tanned eggs.

accessory gland substance in tanning process of eggs. It is possible that the accessory gland secretion may have a substance which delays the normal tanning process by an inhibitory mechanism. Tanning in many insects is reported to be under hormonal control regulated by the abdominal ganglia or brain (CHRISTOPHERS, 1960; TRUMAN & RIDDIFORD, 1974). However, it is not clear whether such a mechanism operates in the tanning of eggs. Since it is well established that the accessory gland substance initiates many physiological changes in female mosquitoes (HINTON, 1974), it is probable that it may initiate changes which would inhibit tanning of eggs before oviposition. This factor is no more available when the eggs are laid and tanning of eggs occurs. The present data thus seem to implicate a probable direct or indirect role of male accessory gland substance in the tanning of eggs of *Ae. aegypti*. Further studies are required to confirm this hypothesis.

REFERENCES

ADLAKHA, V. & M.K.K. PILLAI (1975) Involvement of the accessory gland substance in the fertility of mosquitoes. *J. Insect Physiol.*, **21**: 1453–1455.

CHRISTOPHERS, S.R. (1969) Aedes aegypti (L.) *the Yellow Fever Mosquito*. Cambridge Univ. Press, 739 pp.

TRUMAN, J.W. & L.M. RIDDIFORD (1974) Hormones and behaviour. *Adv. Insect Physiol.*, **10**: 297–452.

HINTON, H.E. (1974) Accessory functions of seminal fluid. *J. med. Ent.*, **11**: 19–25.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 49 *to* 51

BRIEF COMMUNICATION

METABOLIC RESERVES AND FREE AMINO ACIDS DURING THE ADULT LIFE OF *CALLOSOBRUCHUS MACULATUS* (F.) (COLEOPTERA : BRUCHIDAE)

DALBINDER SINGH SIDHU, SURINDER PAL KAUR & NIRMAL KUMAR
Department of Zoology, Punjab University, Patiala, India

(*Received 30 June 1979*)

After 24 hours of emergence both free amino acids (FAA) and glycogen contents decrease in *Callosobruchus maculatus* (F.), while total lipids (TL) rise sharply from 4.1% to 10.4% of wet body weight. FAA, glycogen and TL reach a low level from 48-60 hr apparently due to oviposition which takes place during this period. After a rise, the FAA, glycogen and TL are depleted prior to death.

(*Key words: Callosobruchus maculatus*, free amino acids, metabolic reserves, adult life)

Most of the species belonging to the family Bruchidae (Coleoptera) are pests of stored pulses. Information regarding their biochemical development is quite insufficient. SIDHU & KANG (1979) have reported the fate of metabolic reserves and concentration of FAA pool during the metamorphosis of *Callosobruchus maculatus* (F.). The present study is continuation of that work during the adult stage of this insect. The insect under study does not feed during the adult stage. This investigation is expected to provide some information regarding the metabolism of this insect during this period.

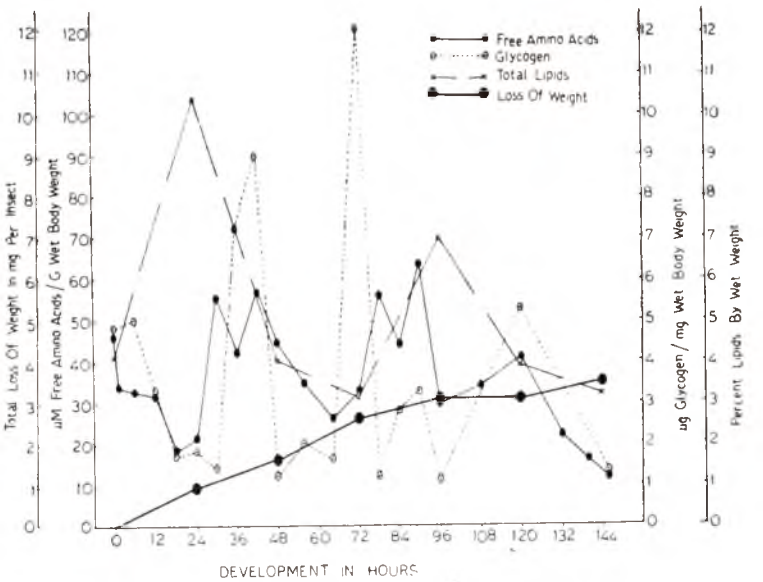
Callosobruchus maculatus was reared in the laboratory as reported by SIDHU & KANG (1979). For the determination of FAA concentration, each test sample of adults of known age and weight was homogenized separately in 1 ml of distilled water and centrifuged at 7,000 rpm for 10 min. To the resultant supernatant 1 ml of ethanol (95% V/V) was added and kept at 50°C in a water bath for deproteinization. The protein precipitates were removed by centrifugation and the supernatant collected was evaporated to dryness at 50°C. The dried residues of each sample were dissolved in ammonia-free distilled water and the FAA extracts obtained thus were estimated colorimetrically (TROLL & CANNON, 1953). Glycogen was extracted from various samples according to VAN HANDEL (1965) and estimated by the method of SEIFTER *et. al.* (1950). TL were estimated according to the method of FOLCH *et al.* (1957).

The results of various estimations of FAA, glycogen and TL are recorded in Table 1 and summarised in Fig. 1. It has been noticed that after a few hours of emergence, there is a significant change in the contents of the above mentioned metabolites. The TL which comprised about 4.1% of the wet body weight at 0 hour increased to 10.4% within 24 hours (Fig.1). At the same time, FAA and glycogen contents declined. The sharp rise in TL immediately after emergence may be due to the conversion of other compounds such as FAA and glycogen etc. to lipids which are apparently stored into the eggs as the insect does not feed during adult stage. The high lipid content in the early adult life of *C. maculatus* is comparable

TABLE 1. Concentration of FAA, glycogen and TL in the adult stage of *Callosobruchus maculatus* (F.).

Developmental period (Hours)	μ moles FAA/ g wet body weight (±SD)	μg glycogen/mg wet body weight (±SE)	mg TL/ mg wet body weight (±SE)	% FAA by wet body weight	% glycogen by wet body weight	% TL by wet body weight
0	45.92±.92	4.8±.096	.04±.005	.60±.012	.48±.009	4.10
1	33.75±.67	—	—	.44±.008	—	—
6	32.66±.65	5.0±.10	—	.42±.008	.50±.010	—
12	31.61±.63	3.3±.066	—	.41±.008	.33±.006	—
18	18.18±.36	1.7±.034	—	.23±.004	.17±.003	—
24	21.42±.43	1.8±.036	.10±.004	.28±.005	.18±.003	10.4
30	55.45±1.19	1.4±.028	—	.72±.014	.14±.002	—
36	42.11±.84	7.2±.144	—	.55±.011	.72±.014	—
42	57.10±1.14	9.0±.18	—	.74±.015	.90±.018	—
48	44.54±.89	1.2±.024	.04±.012	.58±.012	.12±.002	4.05
56	34.71±.69	2.0±.04	—	.45±.009	.20±.004	—
64	26.00±.52	1.6±.032	—	.34±.006	.16±.003	—
72	32.84±.65	12.1±.242	.03±.005	.43±.008	1.21±.024	3.15
78	56.00±1.12	1.2±.040	—	.73±.014	.12±.002	—
84	44.17±.88	2.8±.056	—	.57±.011	.28±.005	—
90	63.73±.27	3.3±.066	—	.83±.016	.33±.006	—
96	29.80±.59	1.1±.022	.07±.005	.39±.007	.11±.002	7.00
108	34.00±.68	—	—	.44±.008	—	—
120	41.34±.82	5.3±.106	.04±.005	.54±.010	.53±.010	3.90
132	22.00±.44	—	—	.28±.005	—	—
140	16.32±.32	—	—	.21±.004	—	—
146	11.50±.23	1.3±.026	.03±.005	.15±.003	.13±.002	3.25

SD – Indicates standard deviation.
SE – Indicates standard error.



Concentration of free amino acids (FAA), glycogen, total lipids (TL) and total loss of weight per insect during adult life of *Callosobruchus maculatus* (F).

to that in the bruchid, *Pachymerus bactris* (COLLIN, 1933).

The decrease in TL, FAA and glycogen from 48 to 60 hr period appears to be due to oviposition which takes place during this period. The loss in body weight is also maximum during this period (Fig. 1) which is apparently due to oviposition.

On 4th day, the FAA, glycogen and TL contents are again high but all the compounds finally register a fall and reach a low level at the end of 6 day starvation period. The metabolism of glycogen in *C. maculatus* is different than the other insects as it does not get completely depleted even after starvation contrary to the findings of HILL & GOLDSWORTHY (1970) in migratory locust.

Acknowledgements—The authors are thankful to Professor S.S. DHILLON, Head, Department of Zoology for providing the facilities to carry out this work.

REFERENCES

COLLINS, G. (1933) Fatty acids from the larval fat of the beetle *Pachymerus bactris* L. *Biochem. J.*, **7**: 1373–1375.

FOLCH, J., M. LEES & G.N. STANELY (1957) A simple method for the isolation and purification of total lipids from animal tissues. *J. biol. Chem.*, **226**: 497–509.

HILL, L. & G.J. GOLDSWORTHY (1970) The utilisation of reserves during starvation of larvae of the migratory locust. *Comp. Biochem. Physiol.*, **36**: 61–70.

SEIFTER, S.S., B.N. DAYTON & E. MUNTYLER (1950) The estimation of glycogen with the anthrone reagent. *Archs Biochem. Biophys.*, **25**: 191–200.

SIDHU, D.S. & HARJIT K. KANG (1979) Metabolic reserves and pool size of free amino acids during metamorphosis of *Callosobruchus maculatus* (F). *Entomon*, **4**(1): 51–59.

TROLL, W. & R.K. CANNON (1953) A modified photometric ninhydrin method for the analysis of amino and imino acids *J. biol., Chem.*, **200**:803.

VAN HANDEL E. (1965) Microseparation of glycogen, sugars and lipids. *Analyt. Biochem.*, **11** : 266–271.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 53 *to* 54

BRIEF COMMUNICATION

NOTE ON THE CHEMICAL CONTROL OF *BER* LEAF WEBBER

R. C. BATRA, G. S. SANDHU* & S. N. SINGH
Department of Horticulture, Punjab Agricultural University,
Ludhiana, India 141 004

(*Received 31 July 1979*)

A sudden outbreak of ber leaf-webber, *Synclera univocallis* WALKER was noticed on ber (*Zizyphus mauritiana*) during September, 1978. The studies were carried out on the chemical trial of this serious pest. On the basis of overall effectiveness, dichlorvos, fenvalerate, monocrotophos and quinalphos gave good control @ 0.05 per cent concentration. Phosalone and corbaryl proved moderate while DDT and endosulfan were least effective for the control of *ber* leaf-webber.

(*Key words :* **ber leaf webber**, *Synclara univocallis*, **chemical control**)

The *ber* leaf-webber, *Synclera univocallis* WALKER (Lepidoptera : Pyralidae) has been reported from Aden, Burma, Ceylon, India, Palestine, South Africa, South America and Syria, under different synonyms such as *Glyphodes univocalis* WLK., *Pagyda traducalis* ZELL., *Samea jarbusalis* WLK., *Spilomela retinalis* LED. and *Zebronia cottalis* WLK. (RAMPSON, 1896).

A sudden outbreak of this pest was observed on *ber* (*Zizyphus mauritiana* LAMK.) in Punjab during September, 1978. The young green caterpillars feed on the chlorophyll within the longitudinal folds on tender leaves. The full grown caterpillars remain hidden inside 2–3 webbed leaves and nibble the leaves leaving behind the network of veins and midrib. Quite often the tender growing points are also eaten up resulting in stunted growth of the plant. No information was available on the chemical control of this pest in India and elsewhere. So, keeping this in view and the increasing economic importance of this leaf webber its chemical control was attempted through high volume sprays using some of the available insecticides on infested *ber* (*Umran* variety) trees.

TABLE 1. Effect of different insecticides for the control of *ber* leaf-webber.

Insecticide	Mean per cent reduction in leaf-webber, caterpillar population after days: 1	15
Carbaryl (Sevin 50 WP)	50.0 (45.0)c	76.0 (60.0)c
DDT (DDT 25 EC)	0.0 (0.0)d	55.0 (47.8)d
Dichlorvos (Nuvan 70 EC)	100.0 (90.0)a	100.0 (90.0)a
Endosulfan (Thiodan 35 EC)	0.0 (0.0)d	70.0 (56.8)c
Fenvalerate (Sumicidin 20 EC)	100.0 (90.0)c	100.0 (90.0)a
Monocrotophos (Nuvacron 40 SC)	90.0 (71.5)b	100.0 (90.0)a
Phosalone (Zolone 35 EC)	50.0 (45.0)c	95.0 (77.1)b
Quinalphos (Ekalux 25 EC)	90.0 (71.5)b	100.0 (90.0)a

Parenthesis are arc sin $\sqrt{\text{percentage}}$
Figures followed by same letter (s) are statistically non-significant (Ducan's multiple range test).

* Department of Entomology, P.A.U., Ludhiana.

The experiment was conducted at the new Horticultural orchard of Punjab Agricultural University, Ludhiana. The average height of plants was 5.5 m and spread of 3.5 m. All the insecticides (Table 1) were sprayed with rocking sprayer at 0.05% concentration, using 5 litres of water per tree, during September, 1978. Each treatment was replicated thrice in a randomised block design, keeping 2 trees as plot size. Observations were recorded on 25 random leaves infested but randomly selected 25 leaves/tree from 4 sides and centre of the canopy before the treatment and 1, and 15 days after spraying.

It is clear from Table 1 that dichlorvos, fenvalerate, monocrotophos and quinalphos registered 100 per cent mortality even after 15 days of spraying.

Phosalone and carbaryl proved insecticides of moderate action and showed only 50 per cent larval reduction and were equal in performance initially and phosalone ultimately proved better than carbaryl 15 days after spraying showing 95 per cent reduction while carbaryl reduced 76 per cent population only. DDT and endosulfan proved to be the least effective of the insecticides tested for the control of *ber* leaf webber.

On the basis of overall effectiveness, dichlorvos, fenvalerate, monocrotophos and quinalphos may be suggested at 0.05 per cent concentration are suitable for the control of *S. univocallis*.

REFERENCE

HAMPSON, G.F. (1896) *The fauna of British India including Ceylon and Burma, Moths.*, Vol. IV. Thacher, Spink and Co., Calcutta. pp. 272.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 55 *to* 57

BRIEF COMMUNICATION

EVALUATION OF SOME INSECTICIDES AGAINST *AMRASCA BIGUTTULA BIGUTTULA* ISHIDA INFESTING RIDGE GOURD

B. L. PAREEK[1] & A. NOOR
Department of Entomology, College of Agriculture,
University of Udaipur, Udaipur, India 313 001

(*Received 21 July 1979*)

Efficacy of fifteen insecticide treatments was evaluated against the jassid, *Amrasca biguttula biguttula* (ISHIDA) infesting ridge-gourd during summer of 1975 at Udaipur. The results indicated that dimethoate (0.03%), methyl parathion (0.025%) and carbaryl (0.2%) were the most effective. Spray of 0.03% dimethoate or 0.2% cabaryl could be recommended to control the jassid infestation.

(*Key words:* **chemical control, jassid**, *Amrasca biguttula biguttula*)

The jassid, *Amrasca biguttula biguttula* (ISHIDA) (Hemiptera : Cicadellidae) has assumed serious dimensions in recent years inflicting considerable losses to cucurbits. Many workers have reported the jassid as infesting cucurbits from time to time besides other crops (HUSAIN & LAL, 1940; PUKHARKAR *et al.*, 1972; NAIR, 1975; NATH, 1976). For the control of this pest insecticides like carbaryl (ATWAL & SINGH, 1969), chlorfenvinphos and endosulfan (SIDHU & SIMWAT, 1973), dimethoate (PATEL *et al.*, 1975) and methyl parathion (ATWAL & SINGH, 1969; DESHMUKH, 1977) have been found effective on various crops. In a bioassay, dimethoate proved most toxic out of 13 insecticides tested (SINGH & TEOTIA, 1978).

In view of the importance of the insect as a serious pest of cucurbits, a field trial was conducted to find out the relative efficacy of some newer insecticides against this pest infesting ridge-gourd, results of which are presented in this paper.

An experiment was laid out in a randomised block design during the summer of 1975 at the Horticultural farm, College of Agriculture, Udaipur. Ridge-gourd, *Luffa acutangula* ROXB. (variety *pusa nasdar*) was sown by dibbling the seeds 50 cm apart on both the sides of one metre wide irrigation channel in plots of size 5×4 m. There were fifteen insecticidal treatments (Table 1) besides control, each replicated thrice. The insecticides were sprayed on the plants on the appearance of jassid infestation. Effectiveness of the treatments was evaluated on the basis of percentage of population reduction of jassids (both nymphs and adults) recorded a day before and 1, 3, 7 and 15 days after the treatment on five randomly selected plants from each replicated plot. The data thus obtained were subjected to statistical analysis using angular transformed values.

Results presented in Table 1 revealed that all the insecticidal treatments were significantly effective in controlling the jassid at all the intervals. Dimethoate and methyl parathion gave significantly better reduction of jassid population than methamidophos, carbaryl (0.1%), dichlorvos, trichlorphon, lindane, fenitrothion and malathion + fenthion at all the intervals except

[1] Present address – Department of Entomology, College of Agriculture, Jobner 303 329 (Rajasthan).

TABLE 1. Effect of different insecticidal treatments on the control of *A. biguttula biguttula*.

Insecticide and conc. (%)	Percentage reduction of jassid population (days after treatment)*	
	1	15
Carbaryl 50 WP, 0.10	81.31 (64.56)	37.85 (37.97)
Carbaryl 50 WP, 0.20	90.84 (72.60)	59.59 (50.56)
Chlorfenvinphos 24 EC, 0.05	88.07 (69.83)	42.73 (40.82)
Chlorpyriphos 48 EC, 0.05	85.72 (67.97)	39.13 (38.72)
Diazinon 20 EC, 0.025	91.25 (73.02)	48.78 (44.31)
Dichlorvos 100 EC, 0.05	83.04 (65.98)	22.00 (27.96)
Dimethoate 30 EC, 0.03	92.77 (74.62)	64.03 (53.11)
Endosulfan 35 EC, 0.05	88.25 (70.27)	47.02 (43.28)
Fenitrothion 100 EC, 0.05	75.79 (60.89)	28.57 (32.27)
Malathion+Fenthion 50 EC (1:1), 0.05	65.15 (53.89)	9.00 (16.94)
Lindane 20 EC, 0.05	80.99 (64.15)	33.64 (35.44)
Methamidophos 60 SC, 0.04	84.10 (66.61)	35.09 (36.29)
Methyl parathion 50 EC, 0.025	93.74 (75.64)	71.43 (57.81)
Quinalphos 25 EC, 0.025	87.11 (69.11)	38.69 (38.46)
Trichlorphon 50 EC, 0.10	79.93 (64.16)	32.44 (34.69)
Control	0.0	0.0
CD at 5%	7.19	3.58

* Average of three replicates; figures in parentheses, denote angular transformed values.

on the 15th day when methyl parathion was significantly superior over all the rest of the treatments. However, dimethoate and methyl parathion were comparable to diazinon, carbaryl (0.2%), endosulfan, chlorfenvinphos and quinalphos in immediate toxicity *i. e.* at 1 day. On the 15th day only dimethoate was equally effective with carbaryl (0.2%) both of which were next to methyl parathion. The treatments of diazinon, endosulfan, chlorfenvinphos, quinalphos and chlorpyriphos constituted an intermediate group in effectiveness at all the intervals. The effectiveness of methyl parathion on the jassid on cotton and sunflower (ATWAL & SINGH, 1969; DESHMUKH, 1977), dimethoate on castor (PATEL *et al.*, 1975), carbaryl on cotton (ATWAL & SINGH, 1969), chlorfenvinphos and endosulfan on *bhindi* (SIDHU & SIMWAT, 1973) recorded earlier agreed with the present findings.

Thus methyl parathion appeared to be the most efficaceous insecticide for the control of the jassid on ridge–gourd. But it could not be considered promising for application on vegetables because of its high dermal toxicity to mammals (ANONYMOUS, 1962) and comparatively longer residual effect. Thus dimethoate (0.03%) or carbaryl (0.2%) could be recommended for the jassids infesting cucurbits.

Acknowledgements:—Thanks are due to the Head, Department of Entomology, Dean, College of Agriculture and Director of Research, University of Udaipur, Udaipur for providing necessary facilities during the course of investigations.

REFERENCES

ANONYMOUS (1962) *Instruction for the Safe Use of Pesticides.* Govt. of India, pp. 8.

ATWAL, A.S. & K.SINGH (1969) Chemical control of cotton jassid (*Empoasca devastans* DISTANT) and whitefly (*Bemisia tabaci* GENN.). *J. Res. P.A.U.*, Ludhiana, **6**: 233–240.

DESHMUKH, S.D. (1977) Insecticidal control of pests of sunflower. *Pesticides*, **11**: 20–22.

HUSAIN, M.A. & K.B. LAL (1940) The bionomics of *Empoasca devastans* DISTANT on some varieties of cotton in the Punjab. *Indian J. Ent.*, **2**: 123–136.

NAIR, M. R. G. K. (1975) *Insects and Mites of Crops in India.* ICAR, New Delhi, pp. 206.

NATH, P. (1976) *Vegetables for the Tropical Region.* ICAR, New Delhi, pp. 37.

PATEL, H.K., J.R. PATEL, S.N. PATEL & A.G. PATEL (1975) The evaluation of new pesticides for the control of sucking pests on Gujarat castor hybrid–3. *Pesticides*, **9**: 25–26.

POKHARKAR, R.N., M.N. BORLE, D.S. AJRI, S.N. KHAIRE & S.E. KALBHOR (1972) Pests of cucurbits, 231, *in: Crop Pests and How to Fight them.* Directorate of Publicity, Govt. Maharashtra. Bombay.

SIDHU, A.S. & G.S. SIMWAT (1973) Evaluation of some new insecticides for the control of *Amrasca devastans* (DISTANT) infesting okra, *Abelmoschus esculentus* (L). *Indian J. Ent.*, **35**: 297–299.

SINGH, R. & T.P.S. TEOTIA (1978) Relative toxicity of some insecticides to the audlts of cotton jassid, *Amrasca biguttula biguttula* (ISHIDA). *Indian J. Ent.*, **40**: 82–85.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 59 *to* 60

BRIEF COMMUNICATION

RESIDUES OF CARBOFURAN IN RICE PLANTS AND ITS TOXICITY TO BROWN PLANT HOPPER

A. B. MOHAMMED ALI, N. MOHANDAS, A. VISALAKSHI & K. P. RAJARAM
College of Agriculture, Vellayani, India 695 522

(*Received 11 October 1979*)

A field experiment was conducted to find out the persistence of carbofuran in rice plants, when applied at 0.54 kg ai ha at different growth stages. Results showed that there was no significant difference in the persistence (as shown from the total carbofuran obtained from the crop) when treated at different growth stages. Bio-assay studies revealed that residues did not give any mortality of BPH confined on leaves or stem.

(*Key words :* **residues, carbofuran, different growth stages, bio-assay**)

Granular formulations of insecticides particularly systemics, are being extensively used in recent years on a number of crops. It is reported to give protection to the crop from pests for 4–6 weeks after treatment (AGNIHOTRUDU & MITYANATHA, 1978). For controlling pests of rice, furadan 3G (cabofuran) is the most widely used granule in Kerala. Absorption and translocation of this insecticide by rice plants at different growth stages, its retention in leaves and stems and consequent toxicity to nymphs of brown plant hopper have been studied and the results are reported in this paper,

A field trial adopting Randomised Block Design with six treatments (including control) (vide Table 1) and three replications were laid out in the silty loam soil (pH 4.5) of the Agricultural College Farm, Vellayani, for the purpose of the above study. Buffer plots were provided to minimise the chances of contamination. Variety *triveni* of 100 days duration was sown and the plants were treated with carbofuran granules (Furadan 3G) at 15 days after sowing and at 15, 30, 45 and 60 days after transplantation @ 0.54 kg ai/ha. Plant samples were collected from treated and control plots at 1, 3, 7, 14 and 21 days after application of the insecticide. Leaf and stem portions were separated and analysed for total carbofuran content following the rapid colorimetric procedure described by GUPTA & DEWAN (1974) and modified to include an acid hydrolysis using 0.25 N HCl for one hour (COOK *et al.*, 1969).

Using samples collected from field at the same intervals as for the chemical analysis 3rd instar nymphs of brown plant hopper were confined separately to leaves and stems of intact rice plants (treated and control) for 72 hours and the mortality was recorded.

Results presented in Table 1 show that within 24 hours after the application of granule to the soil, it was absorbed and translocated to the stem and leaves. The insecticide content did not vary significantly up to 7th day after application. Then there was a downward trend in the total insecticide content reaching low to non detectable levels in 21 days. No significant difference among residues of total carbofuran obtained from crop treated at different growth stages could be noticed.

TABLE 1. Residues of total carbofuran in leaves and stem of rice plants collected at different intervals after application of the insecticide and when applied at different growth stages of the crop.

Growth stages	Residues (ppm) in samples collected at intervals of days					
	1	3	7	14	21	Mean
In leaves						
15 days after sowing	4.68	5.14	6.66	5.55	2.40	4.88
15 days after transplanting	4.17	6.20	7.21	5.36	1.05	4.80
30 ,,	4.58	7.61	3.13	1.60	ND	3.38
45 ,,	4.80	5.20	4.00	2.30	0.95	3.45
60 ,,	4.80	6.80	5.40	4.79	2.80	4.95
Mean	4.60	6.19	5.78	3.90	1.44	..
CD (0.05) for marginal means			..	0.71		
CD (0.05) for combinations			..	1.58		
In Stem						
15 days after sowing	3.93	4.47	2.82	1.26	ND	2.50
15 days after transplanting	1.10	2.45	3.90	2.01	ND	2.21
30 ,,	3.84	3.25	2.35	1.59	ND	2.21
45 ,,	2.66	2.49	1.75	0.80	ND	1.54
60 ,,	1.98	2.30	2.70	0.70	0.36	1.61
Mean	2.70	2.99	2.70	1.27	0.07	..
CD (0.05) for marginal means			..	0.34		
CD (0.05) for combinations			..	0.77		

ND = Non-detectable.

Bio assay studies revealed that the residues did not give any mortality of the insects confined on leaves or stem even-though residues of total carbofuran was present at appreciable levels only. This may be because the lethal factor (pure carbofuran) in the total insecticide content was less than the required dose to kill the insects. These studies also showed that the present practice of applying carbofuran in field @ 0.54 kg ai/ha will not give any satisfactory control of the pest in the silty loam soils of Kerala.

REFERENCES

AGNIHOTRUDU & MITHYANTHA (1978) *Pesticide Residues : a Review of Indian Work*. Rallis India Limited, Bangalore.

COOK, R.F., R.P. STANOVICK & C.C. CASSIL (1969) Determination of carbofuran and its carbamate metabolite residues in corn using a Nitrogen-specific gas chromatography detector. *J. agric Fd. Chem.*, **17**(2): 277–282.

GUPTA, R.C. & R.S. DEWAN (1974) Residues and metabolism of carbofuran in soil. *Pesticides*, **8**(12): 36–39.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 61 *to* 63

BRIEF COMMUNICATION

EFFECT OF GRANULOSIS ON FOOD CONSUMPTION, GROWTH RATE AND UTILIZATION OF FOOD BY CATERPILLARS OF *PERICALLIA RICINI* F. (ARCTIIDAE: LEPIDOPTERA)

BABU M. PHILLIP & ABRAHAM JACOB
Department of Entomology, College of Agriculture,
Vellayani, Trivandrum, India 695 522

(*Received 19 October 1979*)

Growth rate and efficiency of conversion of ingested food of caterpillars were considerably lower when infected with granulosis virus. The higher consumption index noted in diseased larvae was due to reduced feeding period and fresh weight.

(*Key words :* **granulosis**, *Pericallia ricini*, **caterpillars**)

Loss of appetite and cessation of feeding have been observed as common symptoms associated with granulosis infection in insect larvae (TANADA, 1953; HUGER, 1963). Information on the effect of virus infection on food consumed by insects will be useful in assessing suitability of the pathogen for use in microbial control. The present paper reports results of investigations done to assess quantitatively the effect of granulosis on consumption of food, growth rate and utlisation of ingested food in caterpillars of *Pericallia ricini*.

Larvae of *P. ricini* used in these studies were taken from a laboratory culture maintained on castor (*Ricinus communis* L.) leaves. Third instar larvae, 6 to 8 hours old, were inoculated with 5 microlitres of the granulosis suspension by the spot feeding technique of JACOB (1972). Larvae fed on leaf spots treated with five microlitres of 0.1 per cent teepol served as control. Those larvae which had consumed the treated leaf area completely within 4 hours alone were taken for the studies. The infected larvae were transferred individually to weighed castor leaves in hurricane chimneys. Leaves of uniform age and quality were used for this purpose. Every day the quantity of leaf consumed and gain in weight of caterpillars were assessed by weighments. This was continued till the larvae died or pupated. The leaf weights were corrected for transpiration losses.

Indices of consumption and utilisation of food were calculated on wet weight basis after HOPKINS (1912) and WALDBAUER (1964, 1968) as follows :

Consumption Index (CI)

This was calculated by using the relations $\frac{F}{T \times A}$ where F is fresh weight of food eaten; T, duration of feeding period (days) and A, mean fresh weight of animal during feeding period.

Mean body weight of larvae was calculated by summing up the body weight determined every 24 hours and dividing it by the number of weighings (SOO HOO & FRAENKEL, 1966).

Growth rate or the relative growth rate (GR)

This was calculated by the formula $\frac{G}{T \times A}$

TABLE 1. Effect of granulosis on consumption and utilisation of food by larvae of *P. ricini*.

Factors	Healthy		Infected	
	Range	Mean	Range	Mean
1. Consumption of castor leaf per larva (g)	3.915 – 10.040	7.434	0.790 – 1.701	1.201
2. Feeding periods (days)	9 – 11	9.9	5 – 10	8.1
3. Mean weight/larva during feeding period (g)	0.376 – 0.682	0.470	0.062 – 0.095	0.077
4. Weight gain/larva during feeding period (g)	0.851 – 1.720	1.318	0.050 – 0.091	0.071
5. Consumption Index	0.982 – 2.269	1.646	1.320 – 2.795	2.030
6. Growth rate	0.210 – 0.372	0.287	0.084 – 0.197	0.128
7. Efficiency of conversion of ingested food	0.142 – 0.217	0.180	0.042 – 0.099	.064

where G is fresh weight gain of the animal during feeding; T, duration of feeding period (days) and A, mean fresh weight of animal during the feeding period.

Conversion of Ingested food(ECI)

This was assessed in terms of gross efficiency or the efficiency of conversion of ingested food to body substance which was calculated by the relations,

$$ECI = \frac{\text{Weight gained} \times 100}{\text{Weight of food ingested}} = \frac{GR}{CI}$$

Student 't' test used for comparing the difference between means. The experiments were conducted at room temperature which was $28.5 \pm 2°C$. The relative humidity during the period ranged from 85 to 90 per cent.

Data presented (Table 1) reveals that the mean fresh weight of food consumed by diseased larva, was as low as 1.201 g during the experimental period as against 7.434 g consumed by the healthy larvae. Average weight of the infected larvae was 0.077 g in contrast to 0.470g of the healthy larvae. Further, in the infected larvae the rate of gain in weight was very low, it being only 0.071 g per larva as against 1.318g in the healthy larvae.

The consumption indices were 2.030 and 1.646 for diseased and healthy larvae respectively showing an increased index for the infected larvae. The mean growth rate of diseased larvae was 0.128 whereas that of healthy larvae was 0.287 indicating considerable reduction in growth rate in diseased ones. The efficiency of ingested food by diseased larva was also considerably reduced as indicated by a ECI of 0.064 as against the ECI of 0.180 in healthy larvae. Test of significance by Student 't' test showed that the difference between healthy and diseased larvae in relation to all the factors studied were significant.

Results presented will show that though it takes 3 to 12 days for an infected third

instar larva to die. the level of damage caused to the crop by them is insignificant compared to that caused by the normal larvae. This is important when considering the utilisation of this pathogen for control of *P. ricini*. The higher consumption index found associated with the infected larvae appear to be contradictory. But it is caused by the lower mean fresh weight of the infected larvae, and its shorter duration of feeding. In virus infected larvae, the adipose tissues which are the main centre of metabolism in the insect, are also the major tissues affected by the virus. Thus the reduced efficiency of conversion of ingested food and resultant lower growth rate can be attributed to the weakened adipose tissue system.

Acknowledgements:—The authors are grateful to the Kerala Agricultural University for the permission granted to publish the materials which formed part of the thesis submitted by the senior author for the award of M.Sc. (Ag.) degree. Acknowledgement are due to Dr. M.R.G.K. NAIR, Emeritus Scientist, Division of Entomology, College of Agriculture, Vellayani for critically reviewing the manuscript.

REFERENCES

HOPKINS, E.G. (1912) Feeding experiments illustrating the importance of necessory factors in normal dietaries. *J. Physiol., Lond.*, **44**: 425–460.

HUGER, A. (1963) Granulosis in Insects, *in: Insect Pathology* (E.A. STEINHOUSE, Ed.) Vol. I, pp. 538, Academic Press, New York.

JACOB, A. (1972) *Studies on nuclear polyhedrosis of three species of Lepidoptera*, Doctroal thesis, Tamil Nadu Agricultural University, Coimbatore.

SOO HOO, C.P. & G. FRAENKEL (1966) The consumption, digestion and utilisation of food plants by a polyphagous insect, *Prodenia eridania* (GRAMER) *J. Insect Physiol.*, **12**: 711–730.

TANANDA, Y. (1953) Description and characterestics of a granulosis virus of the imported cabbage worm. *Proc. Hawaii. ent. Soc.*, **15**: 235–260.

WALDBAEUR, G.P. (1964) The consumption and utilisation of solanaceous and non solanaceous plants by larvae of the tobacco horn worm *Protoparce sexta* (JOHAN) (Lepidoptera: Sphigidae). *Entomologia exp. appl.*, **7**: 253–269.

WALDBAEUR, G.P. (1968) The consumption and utilisation of food by insects. *Adv. Insect. Physiol.*, **5**: 229–288.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 65 *to* 66

BRIEF COMMUNICATION

PERIOD OF ACTIVITY AND COMPARATIVE ABUNDANCE OF FLOWER VISITING INSECTS ON PEAR AT LUDHIANA (PUNJAB)

G. S. MANN & GURDIP SINGH
Department of Entomology
Punjab Agricultural University, Ludhiana, India

(*Received 31 August 1979*)

The honey bee *Apis mellifera* L., *A. dorsata* FABR. and *A. florea* FABR. were the dominant flower visitors of pear at Ludhiana. The maximum population was that of *A. mellifera*. *A. dorsata* was second in number to visit the flowers. The period of maximum activity of all the three species of honey bees was upto 13.00 hrs. The activity of flower visiting insects was very low on cloudy days. Fruit setting was 2.67 times higher in the open flower-buds than that covered with parchment paper bags. This indicated that bee pollinators play an important role in improving fruit setting in pear.

(*Key words :* **activity period, comparative abundance, flower visiting insects, pear)**

Cross pollination is reported to have some role in enhancing fruit setting in pear (HUTSON, 1925; LAERE, 1957). The present study was undertaken at Ludhiana in 1979 to ascertain the period of activity and abundance of flower visiting insects and their role in fruit setting of pear.

The number of insects visiting the flowers of pear between 9 and 17.30 hours was recorded at hourly intervals. One half each of five trees was observed for a period of 5 minutes to record the insect visit at each occassion. The observations were repeated thrice. For assessing the role of insects in fruit setting, 100 unopened flower buds were covered with parchment paper bags (size 22 × 18 cm) and 100 buds uncovered served as coutrol.

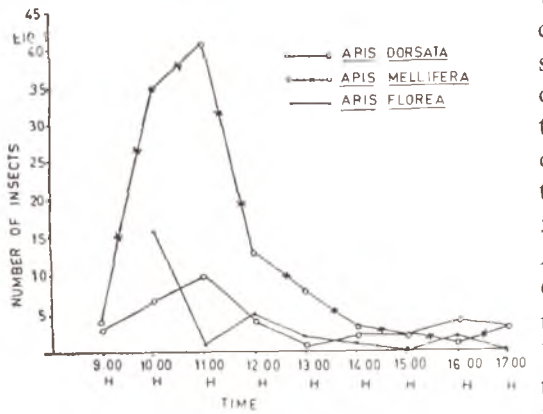


Fig. 1. Period of activity and comparative abundance of honey bees on sunny days.

Apis mellifera L., *A. dorsata* FABR. and *A. florea* FABR. were the dominant flower visitors, the maximum population being that of *A. mellifera* both on sunny and cloudy days (Figs. 1 & 2). *A. dorsata* was second in number to visit the flowers. Some dipterous flies also visited the flowers, but their number was negligible. The bees' activity decreased on the cloudy days. The proportionate decrease in the activity was 59.0, 53.8 and 51.7 per cent in *A mellifera*, *A. dorsata* and *A. florea*, respectively. MC GREGOR (1976) also reported honey bees as the most important flower visitor of pear in USA. The period of activity of all the threes pecies of honey bees was up to 13.00 hrs only after which the activity decreased considerably. The fruit setting was 2.67

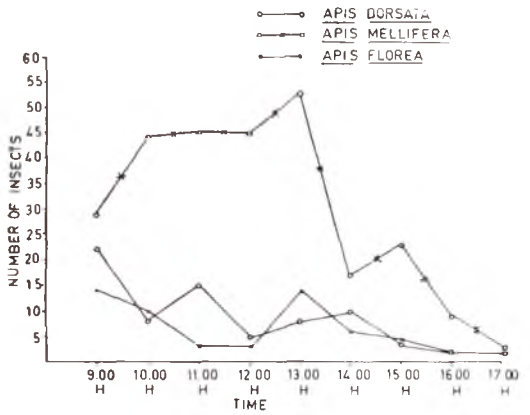


Fig. 2. Period of activity and comparative abundance of honey bees on cloudy days.

times higher in the open flower buds than that in the covered with parchment paper bags. STECHE (1959) also found that in pear, cross pollination by honey bees trebled the crop yield, when compared to the crop with self or nonpollination.

These studies indicate that bee pollinators play an important role in improving the fruit setting of pear under Punjab conditions.

Acknowledgements:—The authors thank DR. A.S. SIDHU, Professor-cum-Head, Department of Entomology, Punjab Agricultural University, Ludhiana for providing the facilities and to DR. G.S. NIJJAR, Professor-Cum-Head, Department of Horticulture, Punjab Agricultural University, Ludhiana for access to the orchard.

REFERENCES

HUTSON, R. (1925) The honey bee as an agent in the pollination of pears, apples and cranberries. *J. econ. Ent.*, **18:** 387–31.

LAERE, O. VAN (1957) The effect of bees on the setting of tree fruit. *Maandbl. van de Vlamase Bieenb.*, **42**(7): 188–213 (In Dutch).

MCGREGOR, S. E. (1976) Insect pollination of cultivated crop plants. *Agriculture Handbook* No. 496 Agric. Res. Serv. USDA, Washington, 411 pp.

STECHE, W. (1959) Effect of pollination by bees on yield and fruit formation in the pear Fondant DeCharneu. *Erwerbsobstoau*, **1**(7): 132–134 (In German).

TUFTS W.P. & G.L. PHILIP (1923) Pear cultivation. *Calif. Agr. Expt. Sta. Bull.*, 373, 36 pp.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp*, 67 *to* 69

BRIEF COMMUNICATION

CONTROL OF MANGO MEALY BUG, *DROSICHA MANGIFERAE* GREEN (MARGARODIDAE : HOMOPTERA) BY APPLICATION OF INSECTICIDES IN SOIL

P. L. TANDON & BECHE LAL
Central Mango Research Station (IIHR), Lucknow, India 226006

(*Received 14 August 1979*)

Two field experiments were conducted during 1975-77 at Golakuan, Lucknow, U.P. on the efficacy of different insecticides applied in the soil against 1st instar nymphs of *D. mangiferae*. Out of nine insecticides tested, methyl parathion dust at 10 gm (ai) and aldrin 0.3% emulsion at 20 litres per tree gave best results. BHC, quinalphos and neem seed cake were ineffective. The insecticides have to be applied in the soil around the tree trunk upto drip circle a few days before hatching of the mealy bugs actually starts.

(*Key words:* **mango mealy bug, *Drosicha mangiferae*, insecticidal control**)

The giant mealy bug, *Drosicha mangiferae* GREEN is one of the most destructive and wide spread insect pests of mango. Nymphs and adult females suck sap from tender shoots, leaves and inflorescence. As a result of excessive desaping ultimately fruit setting is affected. The margarodid first recorded on mango from Lahore, (GREEN, 1903) has gradually spread all over India except Karnataka and Kerala States (TANDON & LAL, 1976). The pest has a wide host range of 71 plant species (TANDON *et al.*, 1978). The insect remains in diapause in egg stage in soil from May to December. By the end of December, 1st instar nymphs hatch out from eggs and migrate to mango trees. The present investigations were carried out to ascertain how far application of insecticides in soil will kill the young nymphs and prevent their migration to the trees.

Two field experiments were undertaken. The first experiment was conducted at Golakuan (Lucknow), U. P. in a grower's mango orchard in a randomized block design, replicated thrice on *dashehari* cultivar of mango using six insecticidal treatments (Table 1). The spray fluids were applied with the help of watering can around the tree trunk at the rate of 20 litre per tree. Insecticide dusts were applied with hand duster from a very low height (15 cm) around the base of the tree and the soil raked to mix the insecticide properly. Results were assessed by taking counts of mealy bugs on 15 inflorescence panicles per tree selected at random after 40 days of application of insecticides.

The second experiment was conducted in the same orchard but on different trees using six insecticides (Table 2). The insecticides were applied around base of tree trunks as in the first experiment about a week before the hatching started. Mealy bug nymph counts were taken on 10 inflorescence panicles/tree selected at random from all sides after 51 days of application of insecticides.

The nymph population in different treatments under first experiment is presented in Table 1. Significant reduction in population of mealy bug nymphs was recorded in methyl parathion, aldrin and chlordane

TABLE 1. Effect of soil application of different insecticides on *D. mangiferae* population (1975–1976).

Insecticide and dosage (ai)	Proprietory formulation	Number of nymphs/ 15 panicles
Chlordane 0.3%	Chlordane 75 EC	152.33 (11.81) +
Chlordane 0.2%	Termex 20 EC	97.00 (9.68)
Aldrin 0.3%	Aldrex 30 EC	75.00 (8.55)
Malathion 0.1%	Cythion 50 EC	148.66 (12.05)
Methyl parathion 6 gm/tree	Folidol 2% dust	51.00 (7.15)
Quinalphos 4.5 gm/tree	Ekalux 1.5% dust	172.00 (13.14)
Control	—	140.33 (11.71)
	SE (m)	±1.22
	CD at 5%	3.77
	CV%	22.97

+ Figures in parenthesis are $\sqrt{\text{N values}}$

TABLE 2. Effect of different insecticides applied in soil on *D. mangiferae* population (1976–1977).

Insecticides and dosage (ai)	Proprietory formulation	Average number of nymphs/10 shoots
Aldrin 0.3%	Aldrex 30 EC	31.00 (5.52) +
Chlordane 0.3%	Chlordane 75 EC	52.00 (7.15)
BHC 50 gm/tree	BHC 10% dust	107.00 (10.22)
Fenitrothion 25 gm/tree	Folithion 5% dust	46.80 (6.83)
Methyl parathion 10 gm/tree	Folidol 2% dust	24.20 (4.89)
Neem seed cake 1 kg/tree	—	103.00 (10.86)
Control	—	136.40 (11.64)
SE (m)		± .82
CD at 5%		0.28
CD at 1%		0.38

+ Figures in parenthesis are $\sqrt{\text{N Values}}$

(Termex). All other insecticidal treatments were ineffective in controlling the insect.

In the second experiment (Table 2) all the treatments were significantly effective in reducing the mealy bug nymph population. Methyl parathion was superior to all other treatments and the second best was aldrin, closely followed by fenitrothion and chlordane. BHC and Neem seed cake were inferior to all other treatments and registered a fairly high mealy bug population.

Keeping in view the two years' results it can be concluded that methyl parathion and aldrin are quite effective in killing the first instar nymphs just after hatching in the soil. The insecticides have to be applied a few days before the actual hatching of the nymphs start. FLETCHER (1927) recommended dusting with calcium cyanide. SEN (1955) found toxaphene 10%, BHC 5% DDT 10% (dusts) at the rate of 225 gm/tree, potassium permanganate 450 gm/tree (4 liters of water), kerosene oil emulsion and calomel ineffective. CHOUDHARY & MAZID (1954) and SEN & PRASAD (1956) recommended the use of 50 per cent BHC and 10% toxaphene respectively. ATWAL (1963) found that first and second instar nymphs congregating in large numbers at the base of the tree trunk could be controlled by spraying 0.04% endrin or 0.04% parathion or dusting with 10% BHC/DDT. PRASAD & SINGH (1976) reported that among BHC, aldrin, chlordane, heptachlor, diazinon and telodrin (500 gm/tree) tested, raking of soil in October and application of 5 per cent aldrin reduced the number of mealy bug nymphs to some extent.

REFERENCES

ATWAL, A.S. (1963) Insect pests of mango and their control. *Punjab Hort. J.*, **3**: 235–238.

CHOUDHARY, S. & S. MAZID (1954) *Handbook of Plant Protection*, Department of Agriculture, Assam.

FLETCHER, T.B. (1927) Report of the Imperial Entomologist. *Sci. Rep. Agric. Res. Inst. Pusa*, 56–57.

GREEN, E. (1903) Remarks on Indian scale insects (Coccidae) with description of new species. *Indian Museum Notes*, **5**(3): 100.

PRASAD, V.G. & R.K. SINGH (1976) Prevalence and control of mango mealy bug, *D. stebbingi* (Green) in Bihar. *Indian J. Ent.*, **38**(3): 214-224.

SEN, A.C. (1955) Control of mealy bug in Bihar. *Indian J. Ent.*, **17**(1): 129–132.

SEN, A.C. & D. PRASAD (1956) Biology and control of the mango mealy bug, *Drosicha mangiferae* GREEN. *Indian J. Ent.*, **18**: 127–140.

TANDON, P. L. & B. LAL (1976) Pest management—mango mealy bug, *Drosicha mangiferae* GREEN (Margarodidae: Heimptera). Paper presented at *All India Fruit Research Workshop* held at Hyderabad, May 24–28, 253–262.

TANDON, P. L., B. LAL & R. P. SRIVASTAVA (1978) New records of additional hosts of mango mealy bug *Drosicha mangiferae* GREEN (Margarodidae: Homoptera). *Indian J. Hort.*, **35**(2): 281.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 71 *to* 72

BRIEF COMMUNICATION

OCCURRENCE OF *SYLEPTA DEROGATA* FB. (LEPIDOPTERA, PYRAUSTIDAE) AS A PEST OF BALSA (*OCHROMA PYRAMIDALE*) IN KERALA

GEORGE MATHEW
Division of Entomology, Kerala Forest Research Institute,
Peechi, Kerala, India 680 653

(*Received 21 July 1979*)

Sylepta derogata **(Lepidoptera, Pyraustidae) is recorded as a pest of the balsa tree,** *Ochroma pyramidale* **in Kerala and observations are given on the nature and intensity of damage.**

(*Key words: Sylepta derogata*, **pest of balsa**)

Balsa, *Ochroma pyramidale* (CAV. ex LAMK.) Urban (Bombacaceaea) is fast growing tree species introduced into India from tropical America. Its wood, being one of the lightest, is highly valued for various uses in aviation and refrigeration industries and for model building. The species was first tried in southern India in 1935 (NAIR, 1753). Since 1947, small-scale experimental plantations were raised in several parts of Kerala by the Kerala Forest Department. Insect damage to an one-year old balsa plantation in Nilambur Forest Division was reported to the Institute in December 1978. The insect was identified as *Sylepta derogata* Fb. (Lepidoptera, Pyraustidae). This is the first report of the occurrence of *S. derogata* as a pest of balsa in Kerala, and possibly in India. Although BROWNE (1968) recorded it as a pest of balsa in the British Commonwealth, he did not specify the contry.

In India *S. derogata* is well known as a pest of malvaceous plants notably bhindi (*Abelmoschus esculentus*) and cotton (*Gossypium* sp.). Other recorded hosts include hollyhock, *Sida* sp., *Hibiscus parviformis, Abutilon indicum*, *Corchorus* sp., *Urina lobata*, *Celosia cristata* (FLETCHER, 1920); bamboo, *Hymenodictyon excelsum*, *Kydia calycina*, *Pterospermum* sp., *Sterculia villosa*, *Thespesia lampas*, *T. populnea*, *Althaea* sp. (Beeson, 1941) and *Ceiba pentandra* (BROWNE, 1968).

The biology of this insect has been described by AYYAR (1940) and SOHI (1964). The life cycle is completed in one to two months. Eggs are laid singly on the undersurface of the leaves. Larvae feed within rolls made by cutting the edges of the leaves. Pupation normally occurs within the leaf rolls.

In January 1979 observations were made in a 10 ha balsa plantation at Nilambur. The plants were one-year old, about 2 m high and planted at an espacement of 5 m by 5 m in a roughly rectangular plot on the bank of a river. Adjacent areas consisted of teak plantations of different ages. Two rows of plants, one lenthwise and the other breadthwise across the plantation, were sampled to assess the damage. Out of 93 plants examined, 26 were infested by the insect, which indicated that above 25 per cent of the plants in the plantation was affected Some of the infested plants were totally defoliated; others showed varying degrees of leaf damage. Generally 3 to 4 rolls

were present per infested leaf and each roll harboured a single larva. Occasionally a single large leaf roll contained several early instar larvae in addition to a late or middle aged larva.

A 5-year old balsa plantation (5 ha) in the same locality was also found infested by this insect though the damage was low. In late January 1979, similar observations were made in an one-year old balsa plantation (4 ha) located in Konni Forest Division. Of 60 plants examined, 14 were infested by *S. derogata* which showed that about 23 per cent of the plants suffered damage.

Like other pests, *S. derogata* has various natural enemies: about 36 species of birds (HUSSAIN, in SOHI, 1964) and 33 species of insects (THOMPSON, 1960) have been reported to attack this species. At Nilambur, two parasites, a chalcid, *Brachymeria lasus* WLK. and an undetermined ichneumonid were recorded.

Control measures using insecticides may not be feasible and economical except in young plantations. However, some control can be achieved by the destruction of alternate host plants of this insect in the vicinity of plantations. At Konni *S. derogata* was found on wild bhindi (*Abelmoschus moschetus*) growing in and around the balsa plantation. *Thespesia lampas*, another host plant of this insect, is also common in Kerala forests. Occasional weeding of such alternate hosts may prove helpful in keeping down the pest population.

Acknowledgements:—Thanks are due to the Kerala Forest Department, particulalry to Shri A.V. VENKITACHALAM, Range Officer, Nilambur, for inviting the attention of the Institute to the pest problem and for facilities extended. I am grateful to Dr. K.S.S. NAIR of this Institute for his keen interest in this study and valuable suggestions. Dr. T. C. NARENDRAN, Department of Zoology, University of Calicut kindly identified the chalcid parasite.

REFERENCES

AYYAR, T.V.R. (1940) *A Handbook of Economic Entomology for South India*. Govt. Press, Madras, 528 pp.

BEESON, C.F.C. (1931) *The Ecology and Control of the Forest Insects of India and the Neighbouring Countries*. Government of India, 676 pp.

BROWNE, F.O. (1968) *Pests and Diseases of Forest Plantation Trees*. Clarendon Press, Oxford, 1330 pp.

FLETCHER, T.B. (1920) *Report of the proceedings of the Thid Entomological Meeting* (Pusa, 3–15 Feb. 1919).

NAIR, K.N.R. (1953) The cultivation of Balsa (*Ochroma lagopus* S.W.). *Indian Forester*, **79**: 163–168.

SOHI, G.S. (1964) Pests of Cotton, 111–148, *in: Entomology in India* (ed. PANT, N.C.), The Entomological Society of India, New Delhi.

THOMPSON, W.R. (1947) *A Catalogue of the Parasites and Predators of Insect Pests*. Sec. 1 Part 9, Commonw. Agric. Bureaux. Belleville, Canada 627 pp.

Entomon, 1979, *Vol.* 5, *No.* 1, *pp.* 73 *to* 75

BRIEF COMMUNICATION

STUDIES ON MASS MULTIPLICATION AND POTENTIALITY OF *CHELONUS BLACKBURNI* CAM. A BRACONID PARASITE OF COTTON BOLLWORMS

M. SWAMIAPPAN & M. BALASUBRAMANIAN
Department of Agricultural Entomology,
Tamil Nadu Agricultural University, Coimbatore, India 641 003

(*Received 17 July 1979*)

The percentage parasitization of *Chelonus blackburni* CAM. (Braconidae) an egg larvae parasite of cotton bollworms was 72.30 and 59.60 in eggs of *Corcyra cephalonica* an alternate host and *Earias vitella* respectively. Its total life cycle in *Corcyra* was 41 days at 28°C ± 1°C and 52 days at 21°C ± 1°C, while it was 19.7 days in *E. vitella* under 28°C ± 1°C. When the parasite was released in field on cotton and bhendi, its recovery was 4.5 and 2.8% respectively.

(*Key words: Chelonus blackburni*, **parasitisation**)

Chelonus blackburni CAM. (Braconidae: Hymenoptera) attack egg stage and completes development in larval stage of host. *Chelonus* sp. was reported to parasitise spotted bollworms of cotton in India (HUSSAIN & MATHUR, 1923) and in Egypt (THOMPSON, 1945). *C. blackburni* was found to parasitise pink bollworm in Hawaii, N. America and Egypt (NOBLE & HUNT, 1937; BRYAN *et al.* 1973, 1976). THONTADARYA & JAI RAO (1977) reported acceptance of eggs of *Earias vitella* aud *Corcyra cephalonica* by the parasite under laboratory conditions. Field release and recovery of this parasite from all the three bollworms viz., *Earias* spp. *Heliothis armigera* and *P. gossypiella* in India were made by THONTADARYA & JAI RAO (1977) and SARKATE *et al.* (1978).

Considering the importance of biological control in the management of the bollworms of cotton the present studies were carried out on mass multiplication of the parasite and on its potentiality as a parasite of the pests. Results of these studies are presented in this paper.

Stock cultures received from Dharwar were multiplied on eggs of *Corcyra* and *Earias*. *Corcyra* egg cards (3 × 3 cm) with 0.05 ml of eggs/card were exposed to adult parasites in a rectangular glass cage (16 × 16 × 36 cm) for oviposition. After exposure the cards were transferred to broken 'pearl millet' grain in plastic cages for parasite development. Eggs of *Earias vitella* laid on muslin cloth by the moth were exposed a similar glass jars with parasites for oviposition. The hatched larvae were then transferred to cotton squares and flowers initially and to 'bhendi' fruit later for parasite development.

To determine percentage parasitization at different temperatures samples of young larvae of parasitised eggs were used. Effect of parasitisation on egg hatching was determined by counting total number of eggs exposed and number of eggs hatched. Un-exposed eggs were counted similarly for correction. Effect of temperature on parasite development was found in terms of mean total life cycle under different temperatures. The mean peak emergence of adult parasites was studied by daily counting of emergence under different exposure periods.

To determine per cent recovery of the parasite in field, field release of 3500 parasites were done in an unsprayed cotton plot during April–June (1978) and 500 parasites in bhendi plot during April–May. Sampled larvae were collected from these plots and parasitisation observed in the laboratory.

The mean percentage parasitisation (mean of 15 replications) in eggs of *C. cephalonica* was 79.4% at 21°C and 75.5% at room temperature (28°) in the laboratory with no significant difference. Under laboratory conditions the percentage parasitisation was more in eggs of *C. cephalonica* (72.90) than in eggs of *E. vitella* (59.60).

The hatching of eggs was reduced due to parasitisation it being 38.4% as against 87.0% in unexposed eggs. This reduction may be attributable to superparasitism or other effects of parasitism on the development of host embryo.

The mean total life cycle of *C. blackburni* from egg to emergence was prolonged at low temperature (21°C) to 59 days while it was 41.0 days under room temperature (28°C) in *C. cephalonica* larvae. At room temperature life cycle of the parasite was much less in *E. vitella* (19.7 days) than in *C. cephalonica* (41.0 days). THONTADARYA (1977) had recorded 25 to 30 days as the duration of life cycle of the parasite in *Corcyra* in Dharwar.

The shorter life cycle in *E. vitella* may be due to its shorter larval period as against prolonged larval period of *Corcyra*.

The peak emergence of adult parasites was between 40 and 48 days under 2 hr and 1 day exposures under room temperature (28°C) without any significance in variation due to exposure time. The peak was prolonged to 69 days under low temperature (21°C) with increased life cycle period. Staggered emergence of adults was evident from the studies irrespective of exposure time though there was definite peak period of emergence of adult parasites. The staggered emergence may in turn depend on physiological condition of the host as observed by BRADLEY & ARBUTHNOT (1938) with *Chelonus annulipes* WES.

Studies on the recovery after field release revealed 4.5% parasitisation of *E. vitella* in cotton and 2.8% in bhendi plots. SARKATE *et al.* (1978) and THONTADARYA & JAI RAO (1977) also had recorded low levels of percentage parasitisation of *Earias* in field releases. Though field recovery of the parasite was low, indication of its establishment could be seen which could be increased by proper synchronisation of release with peak emergence of host adults.

C. blackburni was found to parasitise all the three bollworm of cotton viz., spotted and American and pin bollworms under field conditions (SARKATE *et al.* 1978). Hence the scope for utilizing this parasite in the biological control of cotton bollworms is more.

REFERENCES

BRADLEY, N.G. & K.D. ARBUTHNOT (1938) The relationship of host physiology to development of braconid parasite, *Chelonus annulipes* WES. *Ann. ent. Soc. Am.*, **31**: 355–365.

BRYAN, D. E., R. E. FYE, C. G. JACKSON & R. PATANA (1973) Programmed release of parasites for control of pink bolloworms in Arizona. *Proc. Belt-wide-Cotton Res. Conf.*, 114 pp.

BRYAN, D.E., R.E. FYE, C. G. JACKSON & R. PATANA (1976) *Non-chemical control of pink bollworms.* ARS, USDA. (H) 26 pp.

HUSSAIN, L. W. & V. B. MATHUR (1923) Some parasites of the cotton bollworms (*Earias insulana*) and *Earias fabia* in Punjab. *Rept. Proc.* 5th *Ent. Mtg, Pusa:* 34.

NOBLE, L. W. & W. T. HUNT (1937) Imported parasites of pink bollworm at Presidio, Texas. 1932–1936. *J. econ. Ent.*, **30**: 842.

SARKATE, M.B., A.K. RAODEO, N.R. SEERAS & M.D. JAWALE (1978) A note on the recovery of *Chelonus blackburni* CAM. (Braconidae: Hymenop) an exotic egg larval parasite of cotton bolloworms. *Curr. Sci.*, **47**: 474.

THOMPSON, W.R. (1945) *A Catalogue of the Parasites and Predators of Insect Pests.* The Imperial parasite service, Belleville, Ont., Canada. Sec. I. Part 6: 211.

THONTADARYA, T.S. & JAI RAO (1977) Field recovery of *Chelonus blackbunri* CAM. (Hyme: Braconidae) from the cotton spotted bollworm *Earias vitella* FAB. *Curr. Sci.*, **46**: 687.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 77 *to* 79

BRIEF COMMUNICATION

BIOLOGY OF *LEPTOGLOSSUS AUSTRALIS* (FABR.) (COREIDAE : HEMIPTERA) A PEST OF SNAKE GOURD

A. VISALAKSHI, S. NASEEMA BEEVI, T. PREMKUMAR & M. R. G. K. NAIR
Department of Entomology, College of Agriculture, Vellayani, India 695 522

(*Received 19 October 1979*)

Leptoglossus australis FABR. (Coreidae: Hemiptera) is recorded for the first time infesting snake gourd *Trichosanthus anguina* in Kerala. Egg and nymphal period lasts for 7 and 52 days respectively. Both adults and nymphs feed by sckiag sap from the stem and tender fruits.

(*Key words: Leptoglossus australis*, snake gourd, biology)

Leptoglossus australis (FABR.) the leaf footed bug was observed infesting the vines of snake gourd (*Trichosanthus anguina*) in the College farm during June–July 1979. *L. australis* was reported as pest of passion fruit in Queensland (MURRAY, 1976). In India an allied species *L. membranaceus* (FAB.) was reported infesting fruits of citrus (NAIR, 1975) and of pomegranate (JADHAV *et al.*, 1976). *L. australis* is recorded for the first time as a pest of snake gourd and the observations made on its biology are presented in this paper.

Adult : The adult (Fig. 7) is black with anterior border of mesothoracic shield yellow. Antenna is alternately yellow and black. There is an yellow line behind each eye. Ventral side of the body has many large yellowish spots. A minute yellowish spot is seen centrally on each forewing and on the hind flat tibia. Mesothoracic shield is produced laterally into a spine on either side. Antenna is 4 segmented.

Egg (Fig. 1): Eggs are laid in closely packed single rows of 16–17. They are light brown in colour and cylindrical in shape. The egg hatches in 6–7 days and the 1st instar nymph crawls out of the egg by pushing out the operculum which is on the side of the egg. On hatching the reddish coloured nymphs cluster on the egg shell for some time. Then they move about and start feeding on the tender vines remaining in colonies. The nymphs turn brownish in colour and are very active.

Nymph : The nymph has 5 instars (Figs. 2–6). In the early stages the nymph is reddish in colour. The thorax bears two rows of 3 dark plates dorsally. Foremost thoracic plate carries a spine each dorsally. Two black spines are borne on the head placed in between the eyes dorsally. Antenna is 4 segmented. The 1st and 2nd abdominal segments bear one spine each on either side of median line and two spines on the lateral sides in the 4th and 5th abdominal segments the spines are placed centrally on hard plates. The last 3 abdominal segments have brownish dorsal plates. Each abdominal segment is produced laterally into a black spine. From 3rd instar onwards the hindtibia flattens out as leaf like structure. Wing buds apper in the 3rd instar nymph and abdominal spines become stout and blunt. The thoracic plate starts fusing. In the 4th instar nymph a black line appears on the dorsal side of head on either side of the median line starting from the base of

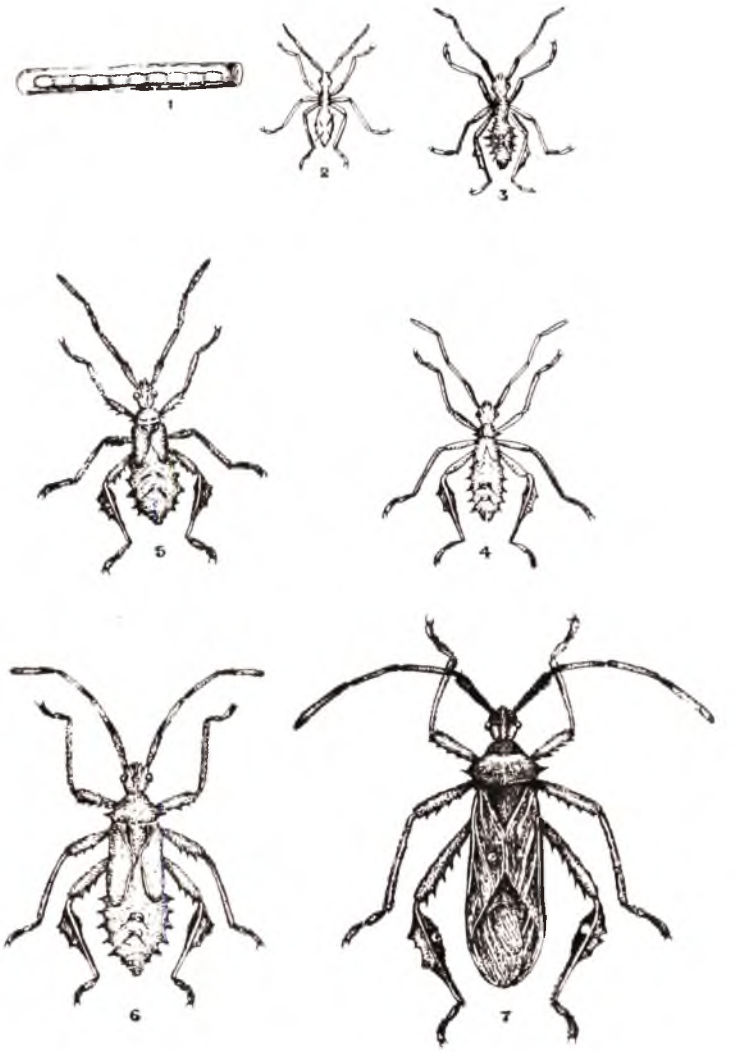


Fig. 1 to 7. Life stages of *L. australis*: 1. Eggs; 2–6. Nymphal instars; 7. Adult.

TABLE 1. Mean duration and measurements of different instars of *L. australis*.

State	Duration in days	Length cm	Width cm	Head width mm	Antenna length cm
Egg	7	1.5	1.0	..	..
I instar nymph	9	0.6	0.1	0.75	0.5
II ,,	7	0.7	0.2	1.00	0.7
III ,,	10	0.9	0.3	1.50	0.8
IV ,,	14	1.0	0.4	2.00	1.1
V ,,	12	1.5	0.45	2.25	1.2
Adult (male)	14	1.9	0.6	2.5	1.5
Adult (female)	10	2.0	0.7	3.0	1.5

the antennae and coming down to neck region in a 'V' shape. The thorax develops an yellow marking on dorsal side from one spine to another.

Final instar is dark brown with reddish head. Wing buds reach upto the base of 4th abdominal segment. Total nymphal period is about 52 days. The duration of the different nymphal instars and adult and their measurements are presented in Table 1.

Due to heavy infestation by adults and nymphs of the insect, the tender vines fade leading to drying up of the leaves. Tender fruits are also seen damaged by the bugs.

REFERENCES

JADHAV, L.D., D.S. AJRI., M.V. KADAM & S. K. DORGE (1976) Leaf footed plant bug on pomegranate in Maharashtra. *Entomologists Newsletter*, **6**: 57.

MURRAY, D.A.H. (1976) Insect pests on passion fruit. *Queensland agric. J.*, **102**: 145–151.

NAIR, M.R.G.K. (1975) Insects and mites of crops in India. Pub. I.C.A.R. 206.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 81 *to* 82

BRIEF COMMUNICATION

DESCRIPTION OF THE MALE OF *SYCOSCAPTERIDEA LONGIPALPUS* (JOSEPH) (HYMENOPTERA : TORYMIDAE)

P. BALAKRISHNAN NAIR & U. C. ABDURAHIMAN
Department of Zoology, University of Calicut, Calicut, India 673 635

(*Received 11 October 1979*)

The hitherto unknown male of *Sycoscapteridea longipalpus* (Joseph) from *Ficus exasperata* Vahl is described.

(*Key words:* **male *Sycoscapteridea longipalpus***)

The female of this fig wasp was described first by Joseph (1953) as *Neosycoecus longipalpus*. Later Joseph (1956) referred it as *Sycoscapteridea longipalpus*, since the genus *Neosycoecus* was synoymized with *Sycoscapteridea*. The male, being not described so far, we give a taxonomic description below. The females which conform with the original description were also collected by the authors.

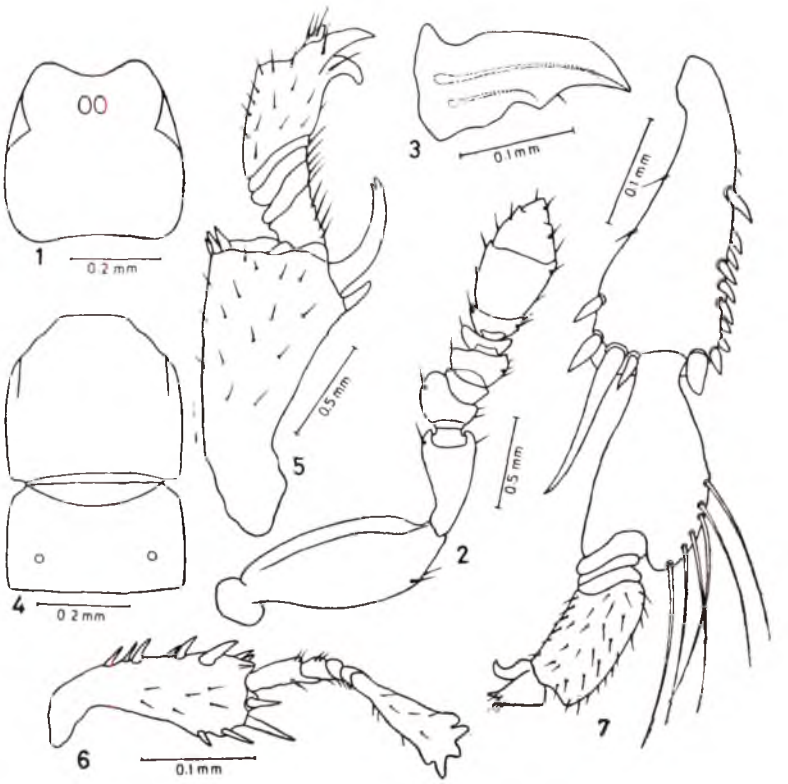
Allotype male

Length 1.4 mm. Body with uniform yellowish-brown colouration, except for the mandibles, which are mostly brownish red, and the eyes which are black.

Head (Fig. 1) : The length a little over the maximum width. Lateral margin forwards of the eye about 1.5 × the longitudinal diameter of the eye. The antennal toruli close together on the middorsal side. The posterior border of the head almost straight. The epistomal margin distinctly concave in the middle. Antenna (Fig. 2) eleven-segmented with one very short annellus. Length of the scape over twice its width, 1.75 × the length of the pedicel; fourth segment cyatheform; seventh and eighth segments of almost equal size; segments 9 to 11 fused to form a club, about twice as long as wide. Mandible (Fig. 3) 2.33 × as long as wide, with two glands as shown in figure.

Thorax (Fig. 4) : Pronotum almost as wide as long, tapering anteriorly. The length of the combined mesonotum and metanotum about 0.8 × their width; propodeal spiracles almost circular in outline. Wings absent. Foreleg coxa wide, 1.25 × as long as femur; tibia (Fig. 5) shorter than femur, with a very long bifid apical spur, a prominent spine on its ventral side and three stout odontoid spines on its dorsal aspect distributed as in figure; tarsal segments approximately in ratio 4 : 1 : 1 : 1 : 8. Midleg tibia (Fig. 6) longest, 1.2 × as long as femur, with small odontoid spines along the dorsal margin, one long apical spur and a few stout spines on the ventral side as shown in figure; five tarsal segments in the ratio 7 : 3 : 1 : 1 : 10. Hindleg tibia 1.12 × as long as femur with many stout spines along the dorsal margin, a long ventral apical spur and a few shorter spines disposed as in figure (Fig. 7); matatarsus expanded, about 0.7 × the length of the tibia and of equal width, provided with six very long macrochaetae; the remaining four tarsal segments in the ratio 2 : 1 : 1 : 12.

Abdomen : Length over twice the width; genital claspers with four claws.



Figs. 1–7. Male of *Sycoscapteridea longipalpus* (Joseph): 1. head; 2. antenna; 3. mandible; 4. thorax; 5. foreleg: tibia and tarsus; 6. Midleg: tibia and tarsus; 7. Hindleg: tibia and tarsus.

Material

Allotype ♂ dissected on slide No. 1/79. **Paratype** 17 ♂♂ kept in alcohol. Collected by P. Balakrishnan Nair, from the figs of *Ficus exasperata* Vahl, Calicut University campus, India dated 17-4-1979.

Acknowledgements:—The authors are thankful to the Head of the Department of Zoology, University of Calicut, for laboratory facilities.

REFERENCES

JOSEPH, K.J. (1953) Description of three new genera and five new species of Sycophagini, with notes on biology, distribution and evolution. *Agra Univ. J. Res. (Sci.)*, **2**: 69–73.

JOSEPH, K.J. (1956) Descriptions of fifteen new and revision of some old species. *Ann. Soc. Ent. France*, **125**: 119

VIEHES, J.T. (1966) Provisional host catalogue of fig wasps (Hymenoptera, Chalcidoidea). *Zool. Verh. Leiden*, **83**: 16.

Entomon, 1980, *Vol.* 5, *No.* 1, *pp.* 83

REPORTS AND NEW RECORDS

RECORD OF *TRICHOGRAMMA AUSTRALICUM* (HYMENOPTERA : TRICHOGRAMMATIDAE) AS A PARASITE OF *ACHERONTIA STYX* WESTW. (LEPIDOPTERA : SPHINGIDAE) :

J. GANGADHARA RAO, P. KAMESWARA RAO & M. SATYANARAYANA MURTHY
Department of Entomology, College of Agriculture, Rajendranagar, India

During the month of October 1978, the eggs of the deaths' head moth, *Acherontia styx* Westw. on brinjal crop were found to be parasitised by *Trichogramma australicum* Gir. in the commercial farm, Rajendranagar. As this was not recorded earlier, this forms the first record. The parasitisation ranged from 79 to 93 per cent. Two successive generations of the parasite have been bred successfully on the eggs of the rice moth *Corcyra cephalonica* St. in the Entomology laboratories of the Agricultural College, Rajendranagar and each generation took seven to nine days on *Corcyra*. Six to ten individuals developed in each egg of *A. styx* while only one to two adults developed in each egg of *Corcyra*.

COTTON SEMILOOPER, *ANOMIS FLAVA* FAB. AS A PEST OF MUSKMALLOW

DWIJENDRA SINGH & S. K. MANCHANDA
Deptt. of Entomology, Central Institute of Medicinal & Aromatic Plants, Lucknow, India 226 007

The muskmallow or muskseed, *Abelmoschus moschatus* Medic. (Family Malvaceae) is cultivated as an essential oil crop in India. The seed is used in the indigenous system of medicine and in perfumery industry. Cotton semilooper, *Anomis flava* was observed as a serious pest on *A. moschatus* during the rainy season at Lucknow, Uttar Pradesh. This insect is a well known pest and have also been recorded by NANGPAL (1948), PUTTARUDRIAH & MAHESWRAIAH (1956), PATEL *et al.* (1964) and RAO & PATEL (1973) on various host plants. It is first record on this crop. However, SINGH *et al.* (1975) working on insect pests of muskmallow in the Punjab has not reported its attack.

The larvae were observed feeding and damaging this valuable crop by making holes in the leaf lamina and in the case of severe attack, the whole leaf excluding main veins are eaten up. In August–September, there were 2 to 5 larvae per leaf. The intensity of attack decreased with the lowering of temperature and the pest disappeared completely in the middle of November.

REFERENCES

NANGPAL, H.D. (1948) Insect pests of Cotton in India. Indian Central Cotton Committee, Bombay, 29–30.

PATEL, H.K., R.C. PATEL & V.V. PATEL (1964) Record of some new insect-pests of different crops, ornamental plants, weeds and stored products in Gujarat state. *Indian J. Ent.*, **26** (3): 365–367.

PUTTARUDRIAH, N. & B.M. MAHESWARAIAH (1956) Some observations on the life history and habits of *Anomis flava* FABRICIUS (Noctuidae : Lepidoptera). *Indian Cott. Grow. Rev.*, **17** (1): 337–341.

RAO, M.S. & R.C. PATEL (1973) Biology and control of okra semiloopper, *Anomis flava* FABRICIUS (Noctuidae: Lepidoptera) on okra. *Indian J. Ent.*, **35**(3): 198–205.

SINGH, BALKARAN, G.S. SANDHU & J.S. BHALLA (1975) Pests of muskmallow, *Abelmoschus moschatus* MEDIC. in the Punjab. *Indian Perf.*, **18**(2): 19–20.

Statement of ownership and other particulars about ENTOMON

(Form IV, Rule 8 of the Registration of Newspapers (Central) Rules, 1956)

1.	Place of publication :	Trivandrum
2.	Periodicity of publication :	Quarterly
3.	Printer's name, nationality and address :	V. K. Kesava Prabhu, Indian. Department of Zoology, University of Kerala, Kariavattom, Trivandrum 695581.
4.	Publisher's name, nationality and address :	– Do –
5.	Editor's name, nationality and address :	– Do –
6.	Name and address of individual who owns the newspaper :	Association for Advancement of Entomology, Department of Zoology, University of Kerala, Kariavattom, Trivandrum 695581.

I, V. K. Kesava Prabhu, hereby declare that the particulars given above are true to the best of my knowledge and belief. : **true**

(Sd.)

Trivandrum,
March 31, 1980.

Dr. V. K. Kesava Prabhu
Publisher, *Entomon*

ACKNOWLEDGEMENT OF GRANTS

The Association for Advancement of Entomology has great pleasure to acknowledge with thanks the receipt of a grant of of Rs. 5000/– from the Department of Science and Technology, Government of India, New Delhi, and a grant of Rs. 2500/– from the Indian Council of Agricultural Research, New Delhi for publication of the journal *Entomon* during the year 1979–1980.

INFORMATION TO CONTRIBUTORS

General: ENTOMON will accept original articles arising from studies on insects and other land arthropods. However, papers purely of morphological, histological or anatomical nature based on light microscopy will not be considered. Material submitted for publication in the journal should not have been published or submitted for publication elsewhere. Copyright of the articles published in *Entomon* will remain exclusively with the AAE. Manuscripts in duplicate, including figures, must be sent by Registered Mail to the *Managing Editor, ENTOMON, Department of Zoology, University of Kerala, Kariavattom, Trivandrum, India 695581.*

Articles should be in English only and may be either *Brief Communications* not exceeding two printed pages, or *Papers* normally not exceeding ten printed pages. Reports not exceeding a column will also be accepted for publication. The authors should consult a recent issue of the journal and follow the style closely.

Text : Papers may, as far as possible, be organised as under: Abstract, Introduction, Material and Methods, Results, Discussion, Acknowledgements, References, Legend, Table, and Foot–notes. All pages should be numbered serially. Brief Communications need not have the above format.

Articles should be neatly type written double spaced, including References, Legend, Tables etc., on one side only of good quality bond paper, leaving sufficient margin.

Foot notes should be avoided as far as possible. When included they should be given on a separate sheet. In the text, reference to foot notes should be indicated by superscript numerals.

Tables should be numbered in Arabic numerals, and should be given on sheets separate from the text. The approximate position of tables in the text should be indicated in the left margin and cirled.

Illustrations should accompany the script separately. The short title of the article and figure number should be indicated on the reverse side of the illustrations. Legend should be typed on sheets separate from the text. Line drawings and photographs should be consecutively numbered together in Arabic numerals without distinction between drawings and photographs. Photographs should be organised and mounted in the form of plates. The approximate position of the illustrations in the text should be indicated in the left margin and circled. Blocks up to an equivalent of one full page size are allowed free of cost. However additional blocks will be fully charged for. Authors are advised to carefully plan their illustration so as to occupy minimum space and permit sufficient reduction. This is in the interest of the authors as well as the journal.

Use only **metric units** as far as possible. Abbreviations of units should not be followed by full stop unless to avoid confusion.

References should be cited in the text by name(s) of author(s) and year of publication as: NAYAR (1958), or (NAYAR, 1958), NAYAR *et al.* (1970) etc. Abbreviate titles of periodicals according to *World List of Scientific Periodicals*, 4th ed., Butterworth, London (1963). The following style should be used for listing references:

Articles in journals: NAYAR, K. K. (1958) Studies on the neurosecretory system of *Iphita*. V. Endocrine basis of oviposition in female. *Proc. Indian Acad. Sci.*, **47B**: 233–251.

NAYAR, K. K., M. BALLS & E. ARTHUR (1970) Transmission of amphibian lymphosarcoma to and through insects. *Oncology*, **24**: 370–377

Books: NAYAR, K.K. (1973) *Elements in Insect Endocrinology*, Prentice Hall, India, 56pp. *Chapter in a book compiled and edited*: GILBERT, L. I. & D. S. KING (1973) Physiology of growth and development: Endocrine aspects, 249–370, *in: The Physiology of Insecta*, Vol. 1, 2nd ed. (ed. ROCKSTEIN, M.), Academic Press, New York & London.

Reprints: No gratis reprints will be supplied. The number of reprints required should be specified as soon as the paper is accepted for publication in the journal. Table showing the cost of reprints will be supplied to authors when acceptance of the paper is communicated.

Editors reserve the right to revise the wording of manuscripts accepted for publication. The authors are solely responsible for the views expressed in their articles.

Reg. No. R. N. 29386 / 76

ENTOMON is covered in the following abstracting / indexing journals : *Chemical Abstracts* (Chemical Abstracts Service, The Ohio State University, Columbus, Ohio 43210, U. S. A.), *Review of Applied Entomology* (Commonwealth Institute of Entomology, 56 Queen's Gate, London SW7 5JR, England), *Current Contents / Agriculture, Biology & Environmental Sciences* (Institute of Scientific Information, 3501 Market Street, Philadelphia, Pa. 19104, U. S. A.), *Biological Abstracts* (Biosciences Information Service, 2100 Arch Street, Philadelphia, Pa. 19103, U. S. A.), *Entomology Abstracts* and other relevant *Abstracts* (Information Retrieval Limited, 1 Falconberg Court, London WIV 5FG, England), *Referativnyi Zhurnal* (The Institute of Scientific Information, Academy of Science of the U.S.S.R., Baltijskaya ul., 14, Moscow A – 219, U. S. S. R).

Printed by V. K. K. Prabhu at St. Joseph's Press,
Trivandrum for the Association for Advancement of Entomology.